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TUBERCULOSIS

TUBERCULOSIS

A TREATISE BY AMERICAN AUTHORS

ON ITS ETIOLOGY, PATHOLOGY, FREQUENCY
SEMEIOLOGY, DIAGNOSIS, PROGNOSIS
PREVENTION, AND TREATMENT

EDITED BY

ARNOLD C. KLEBS, M.D.

WITH THREE COLORED PLATES AND
TWO HUNDRED AND FORTY-THREE ILLUSTRATIONS IN TEXT

NEW YORK AND LONDON
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EDITOR'S PREFACE

A CONTINUOUS and systematic discussion of the whole subject of tuberculosis in all those phases of interest and value to the practitioner by a single author has become an impossibility. In view of the enormous literature—nearly three thousand publications of 1908 alone have been collected in the editor's office—the task of sifting the important from the unimportant can only be undertaken by those who can devote much time exclusively to one distinct phase. The study of tuberculosis thus necessitates a specialization within the range of a special subject.

Every chapter in this book deals with a distinct phase of the subject, and is treated by authors whose particular familiarity with it is well recognized—in several instances even far beyond the boundaries of this country. It has been the endeavor of the editor to bring the articles into proper juxtaposition by personal intercourse and extensive correspondence with the contributors, so that the principal theme is treated in a uniform manner, and does not merely represent a collection of articles, but a consistent whole to fill the requirements of the man in busy practice and without the "cold neutrality" of a mere work of reference. Although the fullest attention has been paid to the fundamental work done in other countries, it is but natural that in this American treatise a full consideration is given to the work done here, the value of which will undoubtedly become more and more generally appreciated. Thus it may be hoped that the international coöperation auspiciously inaugurated at the Washington Congress may also be furthered by this work for the benefit of all concerned.

The guiding consideration of the needs of the practitioner has necessitated a shorter discussion of certain subjects which have received considerable space in other works. An often bewildering completeness has thereby been avoided. A carefully selected bibliography, however, arranged by names of authors and subjects as well, should prove of assist-

ance to those who wish to inform themselves about special questions not extensively discussed in the text. But it may be confidently asserted that the practitioner will find in the following pages a lucid discussion of the great problem of tuberculosis, based upon the most recent conceptions of the international army of busy workers, sufficiently full to aid him in the solution of the ever-recurring puzzles which this disease presents to him as a physician and citizen as well.

The admirable X-ray plates were kindly furnished by Dr. Lewis Gregory Cole, of New York. They are remarkable for their clearness and perfection of detail. It must be borne in mind, however, that these were taken with the patient recumbent, which accounts for the oblique position of the clavicles and certain other minor differences from the picture as seen on the fluoroscope, which is usually used with the patient erect and with the clavicles therefore more nearly horizontal.

Arnold C. Klebs.

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Primary Tuberculosis of Muscles and Fasciæ.
Tuberculous Ischiorectal Abscess and Anal Fistula.
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Frequency of Tuberculosis.
The Sanatorium, its Construction and Management.

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Public Measures in the Prophylaxis of Tuberculosis.

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Tuberculosis of Bones and Joints.
Tuberculosis of the Brain and its Membranes.
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Tuberculosis of the Peritoneum.

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INTRODUCTION

INTRODUCTION

By WILLIAM OSLER

HISTORICAL SKETCH

The history of tuberculosis may be read in full detail in several monographs.[1] Here it will suffice to give a brief sketch of the stages in the development of our knowledge; and perhaps a clearer idea of its evolution may be had by a division into four periods corresponding with the gradual recognition of the great facts in connection with the disease. While these epochs overlap, each represents a special contribution.

Better than any other acute infection, tuberculosis illustrates the methods by which we have slowly reached our present knowledge. During a prolonged period the objective features of disease alone attracted attention, and the modes in which it could be recognized were systematized and defined. For centuries diseases presented only this semeiological phase and nothing was known of the morbid appearances or of the cause, and consequently no efficient steps could be taken for their prevention. At the beginning of the nineteenth century most of the common infections had not got beyond this stage. Not one illustrates more fruitfully than tuberculosis the slow but sure advance of science and of its practical application for the benefit of humanity.

I. **Semeiological.**—The title of one of the lost books of Democritus, *On Those Who Are Attacked with a Cough after Illness*, probably indicates that the pre-Hippocratic writers had practical knowledge of certain features of tuberculosis. In the Hippocratic writings there is much of importance. The disease was recognized as a fever; the association with hemoptysis and with pleurisy was known; an excellent description was given of the phthisical habit and of the general appearance of the chest and of the bulbous fingers. The cause was simple—dropping of the *pituita* from the head into the lungs produced ulceration and fever. Galen did not get much beyond the Hippocratic standpoint, but he is very specific in a strong recommendation of milk diet and a dry climate in the disease. The clinical picture by Aretaeus is one of the best in literature. Celsus, too, has an admirable account and distinguished pulmonary phthisis from the other species of tabes, namely, atrophy

[1] Waldenburg, Predöhl, Johne (see Bibliography).

and cachexia. He recommended long sea voyages, change of climate, particularly Egypt, and a milk diet. There are indications in the old Greek writers that they knew of the contagiousness of the disease. Not much was added to the symptomatology by the Arabian school, which followed slavishly Hippocrates and Galen. Nor did the writers of the Renaissance add much, but Fracastorius recognized very clearly the contagious character of the disease, regarding habitual residence with a consumptive as one of the most common sources. He insisted that the germs could remain attached to the clothing and rooms for a year or more. In the seventeenth century the disease was much more fully considered, and special monographs began to be written. Among these the *Phthisiologia* of Richard Morton, 1689, is perhaps the most important. He recognized the wide prevalence of tuberculosis of the lungs: "Yea, when I consider with myself, how often in one year there is cause enough ministered for producing these Swellings, even to those that are wont to observe the strictest Rules of Living, I cannot sufficiently admire that anyone, at least after he comes to the Flower of his Youth, can dye without a touch of Consumption." He recognized the two types of fever, the acute inflammatory at the beginning and the hectic toward the end. Altogether, the work indicates a wide and accurate knowledge, and the intestinal, the pleural, and the throat symptoms are well described. He had a strong belief in the curability of consumption in its early stages, but warns of its liability to recur. From no seventeenth-century work do we get so interesting a picture of the knowledge of the period, and it is from the hand of a highly educated physician of wide experience. Morton fully appreciated, too, the contagious nature of the disease and gives some striking illustrations. In the writings of Sydenham are to be found many interesting sections on phthisis, but his special contribution was the insistence of the value of fresh air and of horseback riding in the treatment of the early stages of the disease. His remark on the latter is worth quoting: "I am sure that if any physician had a remedy for the curing of a phthisis of equal force with this of riding, he might easily get what wealth he pleased."

If we except Auenbrugger's invention of the art of percussion, I do not know in the eighteenth century of any single contribution of the first rank to the symptoms or signs of tuberculosis, and in the popular text-books on physic at the latter part of the century, and even in the early part of the nineteenth century, as, for example, Cullen's "First Lines," there is not much beyond the description given by Morton. The modern study of the clinical features of the disease dates from the publication of the immortal work, *de l'Auscultation Médiate*, 1819. Not only did Laennec describe the disease anatomically and recognize the

physical signs, but he gave us the first careful study of the healing of tuberculosis, and his article (1819, i, 19) remains to-day one of the best descriptions, clinically and anatomically, of this process. We have here, too, one of the first, as it is to-day one of the best, accounts of the sputa of consumption. Within the next fifty years the careful studies of Andral and Skoda, C. B. J. Williams, Stokes, Austin Flint, and many others, gave clearness and accuracy to our knowledge of the symptoms and physical signs of the disease.

II. **Anatomical.**—Franciscus Sylvius (1614–1672) was the first to describe accurately tubercles in the lungs. He attributed them to enlargement of small glands following upon a scrofulous constitution. He knew that they caseated and broke down to form cavities. He regarded phthisis as identical with *ulcus pulmonum*. Manget, in his edition of the *Sepulchretum of Bonetus*, 1700, described for the first time miliary tubercles. In an autopsy of a person dead of phthisis granules were found in the lungs, liver, spleen, kidneys, mesenteric glands, and intestines, which he compares to *semen millii*. Morgagni did not add much of importance. He raised the question whether the tubercles were really glands. Stark, whose works were published in 1785, fifteen years after his death, gave to miliary tuberculosis its proper pathological and clinical position. Thomas Reid, 1785, insisted that the tubercles were not really glands. Bayle, 1810, is the founder of the modern pathology of tuberculosis. He describes the stages of development and accepts the miliary tubercle as the starting point. At first firm, later they soften and are finally destroyed by suppuration. Such tubercles he describes in nearly all the organs, and he recognized that in these various parts of the body they were related genetically and clinically. For him phthisis was a general disease of a specific nature and by no means to be considered the result of inflammation of the glands or of the lymphatic system. The cheesy substance was a specific material characteristic of the process. He held that inflammation never caused tuberculosis and that the hemoptysis was the result and not the cause of pulmonary phthisis. Laennec agreed with Bayle in regarding the miliary tubercle as the starting point, and held that the miliary granule of Bayle was simply the forerunner of the tubercle, the two bearing to each other the relation of green and ripe fruit. He recognized but one cause of true phthisis, namely, tuberculosis, and he simplified very much Bayle's classification and separated from the disease pulmonary gangrene and carcinoma. The modern view of the unity of phthisis dates from the work of Laennec. Great confusion arose in the middle of the nineteenth century by Virchow's attempt to disprove the specificity of the caseous tubercle in which he saw only one form of tissue necrosis. The term tubercle he restricted to the miliary granule of

Bayle and Laennec, and the miliary tubercle he classed with the lymphomata, developing in preëxisting lymphoid tissue. He thought that caseation in the lungs arose from other processes than tuberculosis. This led to the heterodox views of Niemeyer and others, who carried the dualistic view to such an extreme that they believed the worst fate to happen to a consumptive was for him to become tuberculous. In 1857 Buhl showed that acute miliary tuberculosis was a specific infectious disease. In twenty-three cases he found in twenty-one cheesy nodules, yellow tubercles, or other tuberculous foci. The specific virus was regarded as coming from these cheesy nodules from which the poison was disseminated throughout the body. This prepared the way for the third and all-important stage in the history, and led to the discovery of the true cause of the disease.

III. **Etiological.**—Cruveilhier, in 1826, undertook systematic inoculation experiments, but he thought that tuberculosis resulted from the inoculation of a variety of substances and was not specific. But even before this, in 1789, Kortum attempted inoculation experiments with scrofulous material. In 1843 Klencke stated that tuberculosis was inoculable and made successful experiments in support of this view. A French army surgeon, J. A. Villemin, conclusively demonstrated that tuberculosis was a specific infectious disease. His original paper was read before the Paris Academy of Medicine, December 4, 1865. His epoch-making work, *Études sur la Tuberculose,* published in 1868, is one of the most remarkable contributions ever made to scientific medicine. The experiments were conducted with the greatest care and accuracy, and his work everywhere shows the brilliant scientific investigator. For the period his conclusions were novel and far-reaching, and it is not surprising that they were received with a great deal of scepticism. First, tuberculosis is a specific infection; secondly, it has its origin in an inoculable agent; thirdly, inoculation from man to rabbits is very successful; fourthly, tuberculosis belongs, therefore, to the virulent diseases and should be classed with small-pox, scarlet fever, syphilis, and more particularly with glanders.

In 1877 Cohnheim clinched the question of inoculability by his brilliant experiments (with Salomonsen) in inoculating tuberculous material into the anterior chamber of the eye of the rabbit. The sources of error in previous experiments were eliminated and conclusive proof offered of the specificity of tuberculous material. Klebs was the first to undertake feeding experiments with tuberculous material, and he was able to really cultivate a virus on egg albumen through several generations, and he narrowly missed the detection of the bacillus. The final etiological demonstration was reserved for Koch in 1882, who found a definite bacillus in all forms of tuberculous lesions. He was

able to cultivate the organism through many generations, at the end of which it was inoculable. His observations were quickly confirmed, and it is not too much to say that no single discovery in disease has had a more wide-reaching influence. The remarkable tuberculosis campaign, inaugurated in the eighties, derived its inspiration directly from his work. Many minor points in the etiology remain unsettled, but the great fact remains—the enemy is known, its life history is known, the mode of entrance into the system is known, and this has been followed by the fourth stage in the history of the disease—the period of

IV. **Prevention.**—It was the French who awoke to the fact that in the fight against tuberculosis organization was the first essential, and under the presidency of Chauveau congresses were inaugurated and an attempt made to influence public opinion. The past twenty years has seen one of the most remarkable revolutions ever attempted in sanitation. Throughout the world the most intense interest has been stimulated in the fight against the *white scourge*. Governments have appointed commissions, local congresses have been held, local societies formed, national associations exist everywhere, and an important international congress meets triennially, a permanent international bureau exists, and, above all, a universal enthusiasm has been aroused which has enabled the battle to be carried on with an extraordinary measure of success.

The three important factors concerned with the effective prevention of the disease are a knowledge of the means of transmission, a recognition of the importance of social and personal environments, and a conviction that if taken early and properly treated the disease may be arrested or cured. A knowledge of the sources of infection has been the most potent element in the institution of sound measures for prevention. Hereditary transmission, formerly thought to be one of the most important modes of conveyance, is now believed to play a very minor rôle. A few cases of congenital tuberculosis occur, but the number reported in man is very small. On the other hand, a constitutional susceptibility may be transmitted—i. e., a soil favorable to the growth of the bacillus. The study of the statistics of inheritance in tuberculosis has received a fresh impetus from the work of Karl Pearson, who has applied the new biometric methods to the problem, and his conclusions confirm the belief, intensified in the profession of late years, as to the importance of what the French call *hérédité de terrain*. He concludes that the diathesis of pulmonary tuberculosis is undoubtedly inherited and that the intensity of its inheritance is comparable with that found for normal physical characters in man. After the work of Cornet the belief became general that tuberculosis was transmitted by dust-borne dry sputum, and the chief avenue of infection was through the lungs. Flügge modified this air-borne view by showing that the

danger was not so much from the dust as from infected droplets of mucus and saliva thrown off from the patient in the acts of coughing, speaking, and sneezing. Infection was also thought to be derived from the milk of tuberculous animals. In 1901 Koch denied the susceptibility of human beings to the bovine type of tuberculosis. Commissions in Germany and England have made exhaustive reports, which on the whole are opposed to this view of Koch and show that the bovine form is capable of transmission to the human species. In recent study on the modes of infection von Behring discredits largely the dust-borne infection, and holds that the disease is communicated to the child through the bovine milk. The bacilli readily pass the intestinal mucous membrane and lodge in the lymph glands of the mesentery and of the bronchi, where they remain latent until debilitating circumstances—an acute infection, for example, such as measles—afford an opportunity for successful attack of the latent germs. The general result of von Behring's work has been to call attention to the frequency of infection through the alimentary tract, particularly in children, and through the tonsils and the glands of the neck.

Poverty and tuberculosis are everywhere associated, particularly in the large centers of population. The Vienna figures quoted by Bulstrode ('08) illustrate this in a striking manner. In District No. 1, the best portion of the city, the death-rate from tuberculosis was 11 per 10,000 of the population; the income-tax payers amounted to 25 per cent of the population, and the illegitimate births to 0.8 per thousand, whereas in District No. 10, the poorest section of the city, the death-rate from tuberculosis was 67 per 10,000; the income-tax payers 9.2 per cent of the population and the illegitimate births 9.2 per thousand. This is the case all over the world, and is brought out in a striking manner by the figures collected by Bulstrode in his report. Wherever the population is so crowded that the families live in one or two rooms the tuberculous death-rate is fully double that of districts in which the families live in houses with four rooms and upward. Alcoholism is another factor, the importance of which has been dealt with, particularly by French observers. Neither in England nor in America is the available evidence so striking, but there is no question, I think, that the chronic alcoholic is more prone to succumb to tuberculosis than the temperate man or the teetotaler.

Of course we have to recognize the very widespread prevalence of infection, and only a comparatively few persons reach the age of fifty without a focus somewhere of tuberculosis. Nägeli's estimate of ninety per cent may be high for some localities, but even if we take a moderate percentage of fifty it shows what an enormous number of persons have in them the possibility at least of becoming seriously diseased. In some

it is a small apical puckering, the result of a local infection years before, indicated perhaps at the time by some obscure illness. Another has a small caseous focus incapsulated beneath the pleura, a third has the bronchial glands involved, while a fourth has a focus or two of caseation in the mesenteric glands. Upon the personal hygiene of the individual depends largely whether or not he becomes consumptive. All debilitating circumstances render the body less able to keep the invader in check.

Following directly upon this increased knowledge of the etiology of tuberculosis has come the gratifying recognition of the curability of the disease and of the proper means to be taken for its prevention. We know what the germ is and how it is transmitted. We are able to take measures to prevent its spread in the community, and we know, too, that the nature of the soil is of quite equal importance to the germ. All this has had a direct bearing upon the measures taken for the treatment of the disease. Statistics show very clearly that with the improvement in general sanitation there has been a remarkable reduction in the death-rate from tuberculosis. The death-rate has fallen steadily in the past sixty years from 38.8 per 10,000 in the quinquennial period 1838–42 to 12.1 per 10,000 in the quinquennial period 1901–1905. This is an extraordinary record and almost justifies the hope that tuberculosis may ultimately come within the category of such diseases as leprosy, typhus fever, and malaria, which have been practically abolished. The early recognition of the disease is now everywhere regarded as the first essential in the successful cure of a case. At present we are in the sanatorium phase of treatment, and from the work of Brehmer, Dettweiler, Trudeau, and others we have learned very important lessons in the proper management of cases. But the disease is so widely prevalent that we can never hope to place sanatorium treatment at the disposal of more than a very small percentage of the patients. The brunt of the battle must be borne by the practitioners at large. The better they know the disease, the better equipped they are to recognize it early, the more intelligently will they appreciate the conditions under which, even in homes, it may be arrested or cured.

AMERICAN WORK ON TUBERCULOSIS

Some of the more distinguished American students of tuberculosis may here be mentioned. Benjamin Rush, the American Sydenham, was a very careful student of the problem, and several of the first papers on the disease published in America are from his pen. He regarded it as a debility affecting the whole system, and the cough, ulceration, and purulent discharges from the lungs were the effects of the disease.

He had Sydenham's views of the value of open air and exercise in treatment. He doubted very much if it was contagious. Rush was one of the first students of climatology in America. Samuel George Morton, the celebrated craniologist, was a pupil of Laennec, and learned at first hand from the great master the essentials in the pathology and diagnosis of the disease. In 1834 he published a volume on "Pulmonary Consumption" (the first issued in the United States), which contains a great deal of original matter. Among the American pupils of Louis, William W. Gerhard and Henry I. Bowditch became the recognized authorities on tuberculosis in their day. In 1842 the former published a work on the "Diagnosis, Pathology, and Treatment of the Diseases of the Chest." He was one of the first to contribute a careful study of tuberculous meningitis. Throughout a long and active life Bowditch was always interested in consumption. He early introduced aspiration in pleural effusion, and his study of consumption in New England was a very valuable contribution to the disease. By far the ablest and most scientific of American students of the disease was Austin Flint, whose contributions to the physical signs and the symptoms were among the most important of his many clinical studies. His work on "Phthisis" is of value to-day. There were many other students of the subject, but the names I have mentioned are the most important among those who have passed away. In the past two decades the United States and Canada have seen an astonishing revival of interest in the disease, all aspects of which are being studied with the greatest enthusiasm.

PART I

ETIOLOGY AND MORBID ANATOMY

CHAPTER I

ETIOLOGY—THE TUBERCLE BACILLUS

By MAZŸCK P. RAVENEL

History.—In 1865 Villemin, in his first communication to the French Academy of Medicine on the inoculability of tuberculosis, foreshadowed the nature of the virus in the following words: "Tuberculosis is the effect of a specific causal agent, of a virus. This morbid agent ought to be found, like its congeners, in the morbid products which it has determined by its direct action on the normal elements of the affected tissues introduced into an organism capable of being affected by it. This agent ought then to reproduce itself, and to reproduce at the same time the disease of which it is the essential principle and the determining cause."

In 1877 Klebs, studying tuberculous products by means of his method of fractional cultures, obtained a growth to which he gave the name "monas tuberculosum," and which he believed capable of reproducing the disease when injected intraperitoneally into animals. Schüller ('80) repeated the experiments of Klebs, and obtained like results.

In 1881 Toussaint obtained a growth from tuberculous products, injections of which produced tuberculosis, as proved by the subsequent findings of tubercle bacilli in the tissues of the inoculated animals. In the light of present knowledge it is evident that some true tubercle bacilli must have been carried over from his original material into his cultures. It remained for Robert Koch, in 1882, in a masterly series of studies to demonstrate the true nature of the bacillus of tuberculosis and to obtain it in pure culture. The immense amount of work which has been done since that time has only served to confirm the accuracy of his discovery and to define certain types of the bacillus found in different species of animals.

Types of Tubercle Bacillus.—Soon after the announcement of Koch's discovery, very confusing and contradictory results were obtained by French investigators. Exchange of cultures and further experiments proved that the French were working with cultures obtained from birds, which showed striking differences in growth and virulence from the mammalian bacillus.

Avian Tuberculosis.—Tuberculosis in birds differs markedly from the disease as seen in mammals. It affects almost exclusively the organs of the abdomen, principally the liver, which is enlarged and packed with tuberculous granules. The spleen is almost always affected, showing small whitish nodules. The intestine is rarely ulcerated, but constantly contains nodules which tend to occupy the serous surface. The most striking peculiarity is, however, that the lungs are practically never involved. Lesions of the joints, mouth, pharynx, nose, and eye are met with. Whatever the location or character of the lesion, it contains myriads of bacilli, often so packed together as to obscure the anatomic elements.

Bovine Tuberculosis.—In 1896 and 1898 Theobald Smith called attention to certain differences between the tubercle bacilli obtained from human sources and those from cattle. These differences appear in the morphology, cultural characteristics, and staining reactions, though the most marked feature is the vastly greater pathogenic power for practically all experimental animals shown by the bovine bacillus.

Tuberculosis in cattle presents certain points of difference from the disease as seen in man. Among these may be mentioned the marked tendency of the lesions in cattle to undergo calcification rather than cascation, as seen in man, and the involvement of serous surfaces, such as the pleuræ, peritoneum, etc., with the formation of new growths, beginning as minute, gray, translucent nodules, which increase in size by the proliferation of connective tissue about them and form clusters which assume shapes like bunches of grapes, mulberries, or a cauliflower, hence the names, "Perlsucht," "grape disease." These new growths are frequently very large, even reaching sixty pounds in weight. There is also less tendency to secondary infections, and consequently the ulcerative type of the disease is not common, though large caseous abscesses are frequently seen in the lungs, as well as in other organs.

Tuberculosis is met with in practically every known animal which has come in contact with man. The bacillus isolated from these various animals has always, up to the present time, belonged to one of the two types, human or bovine, and the infection can often be traced to one or the other source. No other species of animal has been found to be affected so constantly with tuberculosis nor to harbor a type of bacillus with such marked characteristics as to warrant a further classification of mammalian tubercle bacilli.

Other types of tubercle bacillus have been isolated from cold-blooded animals, such as the fish tubercle bacillus of Dubard, that found in a turtle by Friedmann, and that produced by Moeller by inoculation of a slowworm with a mammalian culture. These cultures approach the acid-fast group in their characteristics, and there is no evidence that they ever produce disease in man.

Morphology of the Tubercle Bacillus.—The morphology of the tubercle bacillus varies according to its origin, the length of time it has been grown on artificial culture media, the composition of the culture media, and the age of the individual culture examined.

Two types of bacilli are found in man, the *human* and the *bovine*. The human bacillus is a slender rod 0.3 μ in thickness and from 1.5 μ to 5 μ long, its length being from about one fourth to one half the diameter of a red-blood corpuscle. Longer forms are sometimes met with. The rods are straight or curved and occur singly, in pairs, or in small bundles. In old cultures, filamentous clubbed and branched forms are not infrequently seen. The bacilli often stain unevenly, presenting a beaded appearance, due to unstained areas along the rod with deeply stained portions between them.

The bovine bacillus is shorter than the human organism, seldom being more than 2 μ in length, and is somewhat thicker. The rods are straight and often spindle-shaped. Very short forms are common, the length being not more than twice the thickness. They take the stain evenly and deeply, beaded forms not being common, though sometimes seen, especially in tissues.

The two types are quite tenacious of their characteristics, but tend to approach each other under prolonged cultivation, the bovine bacillus coming to resemble the human more closely.

Capsules of Schrön.—These are round, oval, or elliptical bodies, from 1 μ in diameter to 5–6 μ long and 2–3 μ in breadth, the largest exceeding greatly the tubercle bacillus in size. They stain deeply with carbol-fuchsin but decolorize by Gram's method. They are found in tuberculous tissues, especially glands, quite frequently, and are believed to be involution forms of the tubercle bacillus. Walsham states that they are sometimes seen in pure cultures of the tubercle bacillus.

Staining.—The tubercle bacillus stains with difficulty, owing to the large amount of fatty or waxy matter it contains (ten to forty per cent), but having once taken the stain, resists decolorization strongly, a characteristic which enables one to distinguish it readily from the vast majority of other bacteria. In the examination of sputum one can usually be safe in depending entirely on this characteristic, but when examining feces and urine or certain tissues, further precautions must be taken which will be spoken of later.

Various stains have been proposed for demonstrating the tubercle bacillus, but the great superiority of the Ziehl-Neelsen carbol-fuchsin stain over all others has led to its practically universal adoption.

Saturated alcoholic solution of fuchsin.....	11 c.c.
Solution carbolic acid in water (five per cent)..	100 c.c.

In practice a small portion of the material to be examined—sputum, pus, scraping of tissue, cultures, etc.—is spread evenly and thinly on a cover-glass or slide and dried in the air. Next the glass is passed through an alcohol or Bunsen flame three times with about the speed one waves the hand to a friend, the film side being uppermost. This "fixes" the material. Sufficient stain is used to entirely cover the film and heat is applied until steam arises. This is kept up for three to five minutes; the preparation is then washed in water and decolorized until it becomes a faint pink. In doing this it is alternately put in the decolorizer and washed in clear water. The preparation may then be counterstained with methylene blue, washed, and examined wet, or else dried and mounted in cedar oil or balsam. The examination is preferably made without a counterstain, especially if the tubercle bacilli are few in number, since the deeply stained rods stand out very clearly in the practically unstained field, and can scarcely escape detection.

For decolorization sulphuric and nitric acids are the best, and have been used in various strengths up to thirty-three per cent, though the stronger solutions are now seldom employed. The most satisfactory solution for decolorization in the writer's experience consists of

Nitric acid (concentrated)	5 parts.
Alcohol (eighty per cent)	95 "

A very convenient method for the practitioner is that of Gabbett, in which the decolorizer is combined with the counterstain. The film is stained with carbol-fuchsin, as described above, washed and flooded with Gabbett's solution, which should be left on cold for thirty to forty-five seconds, and then washed off in an abundance of water. Gabbett's solution consists of

Methylene blue	2 parts.
Sulphuric acid	25 "
Water	75 "

Ehrlich's anilin-water stain is still preferred for some purposes. Its great disadvantage is that it decomposes rapidly, while the carbol-fuchsin may be kept indefinitely. It is prepared as follows: To 100 c.c. of water add 5 c.c. anilin oil, shake well, then pass through a moistened filter. To the filtrate add drop by drop a saturated alcoholic solution of methyl violet, or fuchsin, until a metallic luster appears on the surface. According to Weigert, 11 c.c. of the stain is added to 100 c.c. of the anilin water. The tubercle bacillus retains the stain when treated with Gram's iodin solution.

In certain lesions, and especially in pus from old abscesses and sputum, it is often impossible to demonstrate tubercle bacilli, though inoculation of these tissues will produce tuberculosis. It has been believed by some that the tubercle bacillus formed spores in the tissues which could not be demonstrated, but accounted for the pathogenicity of these lesions.

In 1900 Marmorek demonstrated the fact that young tubercle bacilli lost their stain when treated with acid—in other words, were not acid-fast—this characteristic being acquired with age and depending on the formation of fatty material.

E. Klebs ('04) published confirmatory and more extensive observations. He describes three stages in the development of the tubercle bacillus seen in cultures on liquid media called "veil," "white layer," and "yellow masses." In the two first no rods can be demonstrated by the usual fuchsin-acid method. Stained with methylene blue, fine particles, among which are rods and granules, may be seen. Granules are seen in great numbers in the "veil," while rods are more numerous in the "white layer" and stand closer to the tubercle bacillus.

Much ('07) investigated the subject, and by the use of a modification of Gram's stain demonstrated two forms of the tubercle bacillus which are not acid-fast. One resembles the ordinary form morphologically, while the other consists of granules which may occur singly, in groups, or connected so as to form little rods. They are usually associated with the rod forms, which appear to be the intermediate stage between the granular and acid-fast rods. Michaelides has confirmed these findings, and describes a form of the tubercle bacillus which is negative to Gram as well as to Ziehl-Neelsen, but takes the Löffler-Giemsa stain.

Herman has for many years employed the following method for staining the tubercle bacillus in sputum, pus, or in tissues. Stain: Crystal violet, three-per-cent solution in ninety-five per cent alcohol. Mordant: Carbonate of ammonia, one per cent in distilled water. These solutions are kept in separate bottles and mixed just before use in the proportion of one part of the stain to three parts of the mordant. The slide, covered with the stain, is heated on a water bath until vapor rises for one minute. It is then decolorized in nitric acid (ten per cent) for a few seconds, and next in ninety-five per cent alcohol, after which it is well washed in water. Eosin (one per cent) makes a good counterstain if it is wished. Herman showed in 1889 that tubercle bacilli could be demonstrated in tissues by this method when others failed. He has recently compared it with the process recommended by Much, and believes it distinctly superior. Not only does it reveal a greater number of bacilli in a given tissue, but where none can be demonstrated

by carbol-fuchsin, and only granular forms by the method of Much, this stain shows whole rods.

Fontes has recently ('09) made studies concerning the fat and waxy substances in the tubercle bacilli and their relation to staining. He finds marked differences in this respect between pseudo and real tubercle bacilli. The pseudo tubercle bacilli vary greatly in their resistance to decolorization, and this is modified by age of the culture. Of ten strains, each showed difference in acid resistance. The following fluid is recommended as a decolorizer for ordinary work in staining tubercle bacilli: absolute alcohol, one part; acetic acid, two parts. After decolorization with this fluid, if one then stains by Gram's method, the pseudo tubercle bacilli give an intensive positive result and show thick granulations. True tubercle bacilli retain the red stain while the intensive Gram positive granulations appear to be separated from one another. In general practice the following stain is recommended for the differentiation of tubercle bacilli from the pseudo bacilli: (*a*) stain preparation with Ziehl's carbol-fuchsin; (*b*) wash in tap water; (*c*) stain for about two minutes with carbol crystal violet; (*d*) treat with Lugol solution until no more metallic mirrors are formed, then treat with acetone alcohol (equal parts of acetone and alcohol); (*e*) wash in tap water; (*f*) stain with methylene blue. After this treatment the tubercle bacilli show red, with violet-colored granulations separated from each other. The pseudo tubercle bacilli are stained violet, without the red border, and show thick granulations. The granulations are usually one to six in number, sometimes eight to ten. If only one is seen it occupies the center of the bacillus. It seems that even if the granulation form is not a characteristic resistance form, at least it is the most resistant form of the tubercle bacillus known to us.

Experiments made with this method in the writer's laboratory seem to substantiate Fontes' claims.

Staining in Tissues.—The tissue is preferably embedded in paraffin, which permits the cutting of very thin sections. The sections are prepared and mounted on slides in the usual way. (1) Stain lightly in alum-hematoxylin. (2) Wash. (3) Stain with carbol-fuchsin, five to six minutes hot or twenty to thirty minutes cold. (4) Wash. (5) Decolorize in acid alcohol. (6) Wash thoroughly. (7) Wash in alcohol (ninety-five per cent) until carbol-fuchsin is removed. (8) Anilin oil, 2 parts; xylol, 1 part. (9) Xylol until clear. (10) Mount in xylol balsam.

The staining reactions of the tubercle bacillus were for a long time considered diagnostic. Koch found only the bacillus of leprosy which might be confounded with the tubercle bacillus, but the differentiation is not difficult. The lepra bacillus takes the stain much more easily

than the tubercle bacillus, coloring in cold aqueous solutions of the anilin dyes in a few minutes. Its grouping, packed densely within the cells, is also characteristic.

Of much more practical importance is the differentiation of the smegma bacillus, especially in the examination of urine, since more than once has the diagnosis of genito-urinary tuberculosis been made and operative procedures resorted to through mistaking this organism for the tubercle bacillus. The smegma bacillus is commonly found about the corona glandis in man and the interlabial folds in woman; also in the inguinal fold, the scrotum, etc., hence it is apt to be found in specimens of urine collected in the usual way.

Grünbaum found the smegma bacillus in fifty-nine per cent of urines from women, but rarely in urine from men. Samples of urine should be drawn with a sterile catheter inserted only after careful cleansing of the meatus and adjacent parts.

Various methods of differential staining have been devised, the most reliable of which is that of Bunge and Trantenroth. It depends on the fact that after immersion in alcohol, or alcohol and ether, the smegma bacillus loses its resistance to decolorizing agents, while the tubercle bacillus under the same treatment retains it. According to Dahms, who has made a careful study of the question, the method is absolutely reliable. It is carried out as follows: (1) Place the spread cover-glass, without previous heating, into absolute alcohol for three hours. (2) Treat with a three-per-cent chromic-acid solution for fifteen minutes. (3) Stain with carbol-fuchsin. (4) Treat with concentrated alcoholic solution of methylene blue for five minutes. The smegma bacillus will be stained blue, the tubercle bacillus red. Dahms says that the smegma bacillus never shows the curved forms so often seen in the tubercle bacillus. Sudan III is also very reliable for differentiation, the only drawback being that occasionally true tubercle bacilli stain very faintly with it.

Other Acid-Fast Bacilli—Pseudo-Tubercle Bacilli.—The researches of the past few years have brought to light a considerable number of organisms which have the power of resisting decolorization by the mineral acids. Owing to this peculiarity, they are spoken of as the "acid-fast" group. They have been found under widely varying conditions and may lead to confusion. Moeller has isolated them from timothy hay, the feces of animals, and human sputum. They have been found in nasal mucus (Karlinski), gangrene of the lung (Rabinowitsch, Benenuti, Ophüls), chronic bronchopneumonia (Birt and Leishman), catarrhal bronchitis (Lichtenstein), milk and butter (Petri, Rabinowitsch, Korn, Kayserling, etc.), earth, seeds, hay, dung, etc., so it must be concluded that they have a wide distribution in nature.

The organisms of this group are readily differentiated from the tubercle bacillus by their rapid growth in culture, their ability to grow at temperatures unsuitable to the tubercle bacillus, and their feeble pathogenicity. Some of them are strongly chromogenic. Moeller suggests the following method of differentiation: Add the suspected material to bouillon and incubate at 30° C. for several days. If rapid multiplication of the acid-fast organisms takes place, we have to deal with the pseudo-tubercle bacillus.

The relation of the pseudo-tubercle bacillus group to the true organism has not been determined. It is supposed by some that a close relationship exists between the two, but this has not been proved. Koch, however, found that the serum of animals which had received injections of attenuated tubercle bacilli would agglutinate the bacilli of avian and fish tuberculosis, the hay and the butter bacillus; and conversely animals treated with the pseudo-bacillus yielded serum which agglutinated the true tubercle bacillus.

Inoculation of small animals with the grass and butter bacilli produces localized and nonprogressive lesions, though the nodules resemble tubercles. They are more prone to undergo softening and suppuration, however. Death is produced only when large quantities are injected. Infected animals do not respond to the tuberculin test.

Cultures may be obtained on ordinary culture media in from twenty-four to forty-eight hours—a sure method of differentiation from the tubercle bacillus.

Diagnosis of Tuberculosis by Microscopic Examination.—A question naturally arises as to the effect of the discovery of this acid-fast group on the value of microscopic findings in the examination of sputum, etc. In the examination of urine, feces, milk, etc., the microscopic examination should be controlled by animal inoculations. Although acid-fast bacilli have been found in bronchitis, gangrene of the lung, and the nasal secretions, such findings are unusual, and with the exception of leprosy there is no evidence that any bacilli which possess the staining peculiarities and morphology of the tubercle bacillus are found in the human body with any degree of frequency. There is in addition an overwhelming mass of evidence regarding the clinical value of the examination of sputum and other morbid products. While the possibility of error, due to other acid-fast bacilli, should always be borne in mind and guarded against, we are nevertheless warranted in placing a high degree of confidence in the routine microscopic examination as described.

Cultivation of the Tubercle Bacillus.—The tubercle bacillus is one of the most strict parasites known, and its cultivation, especially in the first generations, is attended with some difficulty. It requires par-

ticularly an even and exact temperature, preferably slightly higher than that of the blood.

Koch first succeeded in obtaining cultures on coagulated blood serum. Nocard soon after found that the addition of peptone, salt, and cane sugar made a better medium, and later still Nocard and Roux demonstrated the value of glycerin, which is now universally added to culture media and for which no substitute has been found. It is most often added in the proportion of five per cent.

The isolation of cultures is best carried out by the method of Theobald Smith. The medium used is dog's serum, obtained by bleeding in a thoroughly aseptic manner, so that the serum requires no sterilization. It is put into tubes having a ground-glass cap, with a small tubulation connecting with the air, plugged with glass wool. These tubes are slanted in a suitable oven, and the serum is coagulated at a temperature of 76° C. The addition of five per cent glycerin improves the serum. The material from which the culture is to be isolated is inoculated into a guinea pig, which is killed after the disease is developed—usually about three weeks.

The animal is opened carefully with sterile instruments, and portions of the omentum, spleen, liver, or glands are removed to a Petri dish. These are cut into small portions, which are transferred to the surface of the prepared serum. No attempt at breaking up the pieces or rubbing them over the surface must be made. The tubes are placed in an incubator and inclined. The atmosphere of the incubator is kept saturated with moisture by a large dish of water. After about three weeks the pieces of tissues are crushed with a stout platinum needle or glass rod, rubbed over the surface of the serum, and the tubes returned to the incubator. A week or ten days later colonies may generally be seen with the naked eye.

Human cultures not infrequently grow luxuriantly in the first generation, and can almost always be transferred at once to glycerin-agar. Bovine cultures, on the other hand, generally give an exceedingly scanty growth for several generations, giving to the surface of the serum the appearance of ground glass, as first pointed out by Smith. If subcultures are made on glycerin-agar at this stage, one often fails to obtain any growth, and at best it is very scant. It requires a number of generations of artificial cultivation before a luxuriant growth takes place.

Dorset has shown that the tubercle bacillus grows readily on hen's eggs, and that this medium is a most favorable one for the isolation of cultures, growth taking place more rapidly than on blood serum. It is prepared as follows: Eggs, not more than a week old, are carefully broken into a sterile flask and gently shaken to mix the yolk with the

white without the formation of bubbles. When the mixing is complete it is put into tubes, slanted in a blood-serum oven, and coagulated at 70° to 74° C. This usually requires four to five hours on two successive days, sterilization being accomplished at the same time. Before inoculation a few drops of sterile water are added to insure moisture.

Cultures of the human bacillus may be obtained directly from sputum on Hesse's medium. Formula:

Nährstoff Heyden	5 gms.
Sodium chlorid	5 "
Agar	10 "
Glycerin	30 c.c.
Solution carbonate sodium (crystals) 28.6 per cent	5 "
Water	1,000 "

Sputum rich in tubercle bacilli is selected, and a small clump is thoroughly washed by passing it successively through five or more dishes containing sterile normal salt solution. It is then transferred to a dish containing solidified Hesse's agar and drawn over the surface. The plates are incubated in a moist chamber, colonies making their appearance in four to six days.

De Schweinitz and Dorset, from the large amount of phosphorus found in the ash of tubercle bacilli, concluded that a salt of phosphorus would be a desirable addition to culture media for the tubercle bacillus. Tests of various salts showed that the acid potassium phosphate gave the best results. At the Biochemic Division of the Bureau of Animal Industry in Washington the following formula is used for the growth of large quantities of tubercle bacilli for the manufacture of tuberculin: To one part of freshly chopped meat add two parts of distilled water. Keep the mixture at 45° to 58° C. for three hours; strain, boil, and filter. Add Witte's peptone, one per cent; acid potassium phosphate, one half per cent. Bring reaction to one per cent acid to phenolphthalein. Boil one hour, filter, and add glycerin (seven per cent). Examine reaction and adjust to one per cent acid, if necessary.

Homogeneous Cultures.—The tubercle bacillus in ordinary cultures grows only on the surface of the medium, where it has free access to air. On bouillon it forms a thick, wrinkled pellicle over the entire surface, extending a certain distance up the sides of the containing flask, the bouillon below remaining entirely clear. In making such cultures a small piece of pellicle is carefully floated on the surface. If this becomes disturbed and sinks, no growth takes place. Arloing and Courmont have shown that certain cultures may be trained to grow

uniformly through the fluid. To accomplish this the cultures are shaken daily. Such cultures are called "homogeneous," and are used for determining the agglutinating power of the blood. Homogeneous cultures are difficult to produce, but subcultures grow readily and retain their characteristic growth indefinitely.

Having once accustomed the tubercle bacillus to growth under artificial conditions, luxuriant cultures are obtained without difficulty. The media commonly employed are agar-agar and bouillon, to which five per cent glycerin has been added, and potato soaked in a five-per-cent aqueous solution of glycerin.

When large quantities of tubercle bacilli are needed, as in the manufacture of old tuberculin, glycerin-bouillon in flasks which give a large surface is generally employed, as the growth takes place only on the surface of the culture medium where the access of air is free.

Biology of Tubercle Bacillus.—The tubercle bacillus is a nonmotile, aërobic and facultative anaërobic organism. It is a strict parasite, not having a habitat outside the bodies of man and animals. It belongs to the higher bacteria, standing intermediate between the true bacteria and the higher fungi known as hyphomyces. It appears to be closely related to the actinomyces, occasionally forming clusters much like the "Drüsen" of this fungus.

For artificial cultivation it requires a temperature about that of human blood. The optimum temperature is slightly higher than this 38° to 38.5° C. The limits between which growth will take place are 30° to 42° C. for mammalian, 25° to 45° C. for avian cultures. Cultures which have been grown for a long time on artificial media become less susceptible to differences in temperature. Sander, after prolonged cultivation, reports having obtained growth on glycerin-potato broth at 22° to 23° C.

The discovery of tuberculosis in carp, traced to the deposit of human sputum in the pond in which they were reared, and the development of the slowworm bacillus by Moeller, indicate that the tubercle bacillus can become accustomed to temperatures at which it ordinarily refuses to grow. Cultures from fish and the slowworm grow at room temperature, and will not grow at body heat. However, the tubercle bacillus does not find in nature conditions suitable for its development, and there is no evidence that it has a habitat outside of the living body. The vast numbers thrown out in sputum, dejecta, and other pathologic materials, do not reproduce their kind, and meet a more or less speedy death through the action of drying, light, putrefaction, and such agencies. Unfortunately, they survive a sufficient time to gain entrance to the bodies of other men and animals, where favorable soil for growth may be found, and thus the vicious circle is kept up.

Spore Formation.—The unstained areas or vacuoles so often seen in the bacilli are supposed by some observers to be evidence of spore formation. By others the deeply stained points are believed to be spores. The fact that tuberculosis can be produced in animals by the inoculation of caseous matter in which tubercle bacilli are not readily found under the microscope has also led to belief in the formation of spores. It is impossible to speak positively on the matter, but the evidence against spore formation is very strong. The resistance of the tubercle bacillus to destructive agents, while in some respects greater than commonly found in nonspore-bearing bacteria, is not nearly equal to that of true spores. Furthermore, the occurrence of a number of these areas in a single bacillus is strongly against their being spores.

Resistance.—When thoroughly dry, tubercle bacilli can survive a temperature of 100° C. for one hour (Muir and Ritchie). If moist, they are usually killed after one hour at 70° C. Theobald Smith has shown that when suspended in distilled water, normal salt solution, milk, or bouillon, and care is taken to insure even heating, the bacilli are killed in from fifteen to twenty minutes at 60° C., the majority being destroyed in five to ten minutes. In milk the pellicle which forms when heated to 66° C. may contain living bacilli after one hour, hence the ordinary home pasteurization of milk may fail to destroy all tubercle bacilli. Russell and Bang have confirmed these results. Cold has practically no destructive effect on the tubercle bacillus. It retains its virulence intact for as long as six weeks, exposed to cold at times as low as 10° C. below zero (Cornet).

Light, both direct sunlight and diffused, rapidly kills the tubercle bacillus. Jousset found that tuberculous sputum was certainly sterilized after forty-eight hours' exposure to either direct or diffused sunlight. Twitchell found that sputum was incapable of producing a lesion after seven hours' exposure to direct sunlight, which corresponds closely with Koch's original observation that the tubercle bacillus was killed by exposure to direct sunlight in a few minutes to several hours, according to the thickness of the layer exposed.

Drying.—Koch found that sputum dried at the temperature of the laboratory was virulent for guinea pigs after eight weeks. Schill and Fischer found that when quickly dried, sputum retained its virulence for four months; after seven months its virulence was lost. Twitchell found that sputum kept on a handkerchief, a woolen blanket, and on wood at room conditions produced lesions in guinea pigs after seventy days, but not after one hundred and ten days. Sputum on a carpet caused lesions after thirty-nine days, but not after seventy days.

Decomposition.—Widely differing results have been obtained by different experimenters, but it may be stated positively that the tubercle

bacillus is not as rapidly destroyed by decomposition as other pathogenic organisms. Virulent bacilli were found by Twitchell in sputum kept in a sealed bottle placed in a moist, dark box, after one hundred and seventy days, but not after one hundred and eighty-eight days. Other observers state that decomposition diminishes the virulence of tuberculous material rapidly, and that it is sometimes entirely destroyed within a few days (Falk, Baumgarten, Fischer, quoted by Cornet).

Tuberculous tissues retain their virulence after burial in the soil for a long time. Cadéac and Malet obtained positive results by the inoculation of lung buried for one hundred and sixty-seven days. Petri found that the tissues of a tuberculous rabbit remained virulent for three months and six days when buried in a zinc box, but for only one month and five days when a wooden box was used. Galtier found that tuberculous tissues immersed in water renewed from time to time remained virulent for two months. Chantemesse and Widal found cultures alive after immersion for seventy days in sterilized Seine water, though virulence was lost. Sawizky subjected sputum to conditions such as ordinarily found on the floors of dwellings, and found that it retained its virulence for two to two and a half months.

In general it can be said that darkness and moisture favor retention of life and virulence in the tubercle bacillus, but it must be borne in mind that rapid drying also preserves vitality for long periods of time. This condition is fulfilled in the usual bedroom by the small particles of sputum thrown out during sneezing and coughing.

Chemicals.—The tubercle bacillus in pure cultures is killed by a five-per-cent solution of carbolic acid in thirty seconds; by a one-per-cent solution in one minute. Corrosive sublimate (1–1,000) destroys it in ten minutes. Many other chemicals, such as trikresol (one per cent), lysol (two per cent), formalin, etc., rapidly destroy its vitality. Unfortunately, the disinfection of morbid products, especially sputum, is a much more difficult matter, yet in the daily life of the physician this is the problem which confronts him. Carbolic acid (five-per-cent solution), added to an equal volume of sputum, will disinfect in twenty-four hours if the mixture is stirred. Weaker solutions require much longer time.

For the *disinfection of sputum* Rosenau advises formalin (fifteen to twenty per cent), trikresol (two per cent), or lysol (two per cent). At least an equal volume of the disinfecting solution must be added to the sputum, thoroughly mixed, and allowed to stand two hours. Corrosive sublimate is not a good disinfectant for sputum, owing to the coagulation which takes place. Some other chemicals are efficient, but their cost puts them out of the range of usefulness for practical purposes.

Chemical Composition of the Tubercle Bacillus.—The first chemical analysis of tubercle bacilli was made by Hammerschlag, who obtained his material from agar and broth cultures. More extensive analyses on larger amounts of bacilli have been made by de Schweinitz and Dorset, E. Klebs, Ruppel, Aronson, Levene, von Behring, Römer and Ruppel, and others. The chemical composition varies greatly according to the media on which the cultures are grown, as shown by de Schweinitz and Levene.

Analyses of Tubercle Bacilli.[1]

de Schweinitz and Dorset.

	Dried at 100° C.		Ash-free.	
	Cultures on Broth.	Cultures on Asparagin Synthetic Media.	Cultures on Broth.	Cultures on Synthetic Media, Asparagin.
C	61.55 per cent.	62.16 per cent.	63.33 per cent.	63.35 per cent.
H	8.59 " "	9.19 " "	8.88 " "	9.36 " "
N	7.55 " "	8.94 " "	7.74 " "	9.14 " "
S	0.44 " "	0.22 " "	0.45 " "	0.23 " "
P	0.82 " "	0.66 " "	.....	.....
Ash	4.03 " "	1.92 " "	.....	.....

	Hammerschlag.	Levene.	
	Cultures on Agar and Broth.	Cultures on Broth.	Cultures on Mannite, Synthetic Media.
Alcohol and ether extract	27.02 per cent.	31.56 per cent.	22.18 per cent.
C	51.62 " "	55.58 " "	47.41 " "
H	8.07 " "	8.46 " "	7.05 " "
N	9.09 " "	9.39 " "	7.91 " "
S	.....	1.39 " "	0.25 " "
P	.....	0.59 " "	2.67 " "
Ash	8.00 " "	5.92 " "	10.00 " "

Analyses of Tubercle Bacilli, showing Organic Constituents.

	Hammerschlag.	de Schweinitz and Dorset.				Ruppel.
		Dried at 100° C.		Ash-free.		
		Broth.	Asparagin.	Broth.	Asparagin.	Broth.
Fat	27.2%	42.33%	42.01%	43.90%	42.87%	23.5%
Proteid	26.9%	46.34%	55.87%	48.10%	57.12%	31.7%
Carbohydrate, or other residue	28.1%	7.16%	7.46%	4.75%	4.84%	44.8%
Ash	8.0%	2.90%	1.92%	.....	.....	.....

[1] Tables taken from article by Dr. E. R. Baldwin in Nothnagel's Encyclopedia.

Ash.—Analysis of the ash from glycerin-bouillon cultures of feebly virulent bacilli by de Schweinitz and Dorset gave the following:

Na_2O	13.62 per cent.
K_2O	6.35 "
CaO	12.64 "
MgO	11.55 "
SiO	0.57 "
P_2O_5	55.23 "

In a later series of determinations made on cultures from several sources and grown on media containing 0.5 per cent acid potassium phosphate, they found the P_2O_5 varied as follows: Bovine bacilli, 58.04 per cent; swine bacilli, 56.48 per cent; horse bacilli, 55.40 per cent; avian bacilli, 55.63 per cent; attenuated human bacilli, 74.38 per cent; virulent human bacilli, 60.90 per cent. The amount of phosphorus varies directly with the amount of fat in general.

Fats.—The tubercle bacillus is unique in having the largest amount of fatty or waxy matter of any known micro-organism. It almost certainly owes its ability to resist injurious agents to these substances, and as first shown by Klebs its peculiar staining reactions are due to the same cause. The fat is difficult to extract entirely, and is made up of a number of substances whose nature has not yet been satisfactorily determined. The amount of fat is influenced greatly by the composition of the culture medium, and especially the amount of glycerin employed. Ruppel found that the fat content varied with the age of the cultures from 8 to 10 per cent up to 25 to 26 per cent.

According to the culture and method employed, the following percentages of fat have been obtained: Hammerschlag, 26.2 per cent; Klebs, 22 per cent; de Schweinitz and Dorset, 37 to 42 per cent; Aronson, 20 to 25 per cent; Ruppel, 8 to 10 per cent to 25 to 26 per cent; Kresling, 25 to 40 per cent.

De Schweinitz and Dorset believed the fat to be made up of the fatty acids—palmitic, arachidic, and possibly lauric. Ruppel extracted three kinds of fat from the tubercle bacillus: (1) By cold alcohol, a greasy red material containing free fatty acids and a residue melting at 55° to 60° C., and readily saponified; (2) by hot alcohol, a colorless waxy matter melting at 65° C., probably the fatty acid-esters of some higher alcohols (palmitic and stearic); (3) by ether, a wax, melting at 65° to 70° C., probably containing the fatty acid-esters of ceryl and myricil alcohols.

Kresling obtained the largest amount of fat from the tubercle bacillus by extraction with chloroform (35 to 36 per cent), next by benzol

(34.31 per cent), then by ether (30.75 per cent), and alcohol (24.76 per cent). He found the fatty matter to be made up of free fatty acids (14.38 per cent), neutral fat, and fatty acid-esters (77.25 per cent. He considers the composition of the fat of the tubercle bacillus as peculiar to itself. De Schweinitz and Dorset determined the fat in a number of different cultures by ether, alcohol, and chloroform extraction, with the following results: Bovine bacilli, 26.32 per cent; swine bacilli, 20.59 per cent; horse bacilli, 31.76 per cent; avian bacilli, 30.65 per cent; virulent human bacilli, 28.03 per cent; attenuated human bacilli, 37.41 per cent. All cultures were grown on the same medium.

Levene studied only the waxy substance. He found that benzol and toluol were the best solvents. The melting point was 55° to 60° C., and it contained C, 66.62 per cent; H, 11.30 per cent; O, 22.08 per cent.

Proteids.—Hammerschlag first recognized proteid in the residue of the tubercle bacillus after extraction with alcohol and ether. Levene, from cultures grown on synthetic media, extracted three proteid substances which coagulated respectively at 56° to 64° C., 72° to 75° C., and 94° to 95° C. The first substance was precipitated by magnesium sulphate (fifty to eighty-five per cent) and by saturation with common salt, the second by saturation with magnesium sulphate, and the third by saturation with ammonium sulphate. All three contained phosphorus, the greatest amount being found in the third. The same three substances were found in an ammonium chlorid extract of beef-broth cultures. No ordinary albumin was found, the body substance being made up chiefly of nucleo-proteids. The study of the extracts gave no evidence of the formation by the tubercle bacillus of true toxalbumins, analogous to those found in some other pathogenic organisms.

Carbohydrates.—Hammerschlag and de Schweinitz and Dorset obtained reactions showing the presence of carbohydrates in cultures of tubercle bacilli, which the former believed to be due to cellulose. Levene isolated from both broth and mannite cultures a glycogenlike substance which does not reduce Fehling's solution, but acquired the reducing power on being heated with mineral acids. It was obtained from the sodium chlorid and ammonium chlorid extracts, and also from the residue after extraction. It contained only traces of nitrogen and phosphorus, and gave with iodin a color test similar to that of glycogen.

Poisons of the Tubercle Bacillus.—The poisons formed by the tubercle bacillus are complex in character and not well understood. The original *tuberculin* of Koch contained a number of substances, among which were proteids resistant to heat and closely allied to the albumoses. It is doubtful if it contained any true toxin. Analysis of tuber-

culin shows that it contains proteids which differ from any known albumoses or toxalbumins by their power to resist heat. Klebs and Hunter found alkaloids, but Kühne failed to detect them. He found an albuminate, a peculiar (acro) albumose, deutero-albumose, traces of peptone, and tryptophan, a digestive product. The active principle of tuberculin has been shown to be in the nucleo-proteids and their derivatives. Baldwin and Levene recognized that the active principle existed in crude tuberculin in combination with a proteid.

Ruppel, who made a thorough study of the poisons of the tubercle bacillus, found the filtrate from cultures to be entirely nonspecific, and to contain no toxic substance except albumoses. He failed also to isolate any specific poison from the bacilli by extraction. From crushed bacilli, however, he isolated two poisonous substances—*tuberculinic acid*, a nucleic acid containing 9.42 per cent of phosphorus, and a protamine which he called *tuberculosamine*.

Tuberculinic acid is the most poisonous substance yet isolated from the tubercle bacillus, being three and a half to four times as strong as dry old tuberculin. From tuberculinic acid Ruppel and Kitishima prepared *tuberculothymic* acid and a still more poisonous substance, which was isolated in crystalline form, called *tuberculosine*. It is twenty-five to thirty times as poisonous as old tuberculin, and is believed by Behring to be the poison nucleus, without which the specific tuberculin reaction cannot take place. Ruppel considers these substances as derivatives of the cell nucleus.

Levene has analyzed tuberculinic acid obtained from the extracts of tubercle bacilli and also from the nucleo-proteid. The average composition was: C, 33.66 per cent; H, 5.83 per cent; N, 9.62 per cent; P, 11.33 per cent. He found that the composition of various samples obtained by him varied greatly. He isolated from tuberculinic acid *thymin* and *cystosin*.

In 1897 de Schweinitz and Dorset isolated from cultures of tubercle bacillus on liquid medium a crystalline substance soluble in ether, alcohol, and water, which had a necrotic effect on the liver when injected into guinea pigs. They identified it as *teraconic* acid, an unsaturated acid of the fatty series.

Of the substances which have been isolated from the tubercle bacillus so far, the nucleo-proteid and its derivatives produce the most marked effects. Tuberculous animals give typical tuberculin reactions, local and general, following injections of these products, and death is caused by very small doses.

Toxin Formation.—No one has yet demonstrated the formation by the tubercle bacillus of true toxin, and it is doubtful if it produces one. It has been shown that none of the poisons so far isolated are toxins,

and the analysis of Levene proved the absence of toxalbumins from extracts of the bacillus. Poisonous substances have been found in the blood and urine of consumptives and in tuberculous tissues of animals, but their nature has not been proven.

Baldwin believes that the symptoms and toxemia of tuberculosis are fairly accounted for by the presence of the nucleic acid products in the blood, and that the intimate combination between the nuclein and wax, which is so resistant to absorption, explains tubercle formation and the slow poisoning.

Preparation of Tuberculin.—The original tuberculin of Koch was prepared by growing tubercle bacilli on bouillon made from fresh veal, to which was added dried peptone (one per cent), sodium chlorid (one half of one per cent), glycerin (five per cent). When full growth had taken place (six to eight weeks) the cultures were poured out into an evaporating dish, placed on a water bath, and evaporated to one tenth of the original volume. The remains of the bacteria were then removed by filtration. The resulting liquid contained fifty per cent of glycerin and was very stable. The process has been modified in various ways, the object being the same—to make a hot glycerin extract of the intracellular poisons of the tubercle bacillus. At the laboratory of the State Livestock Sanitary Board of Pennsylvania, where large quantities of tuberculin are made for use in cattle, the fully grown cultures without being opened are placed in a steam sterilizer and kept in streaming steam for five to six hours. The bacteria are removed by filtration through paper, and the filtrate concentrated on a water bath to one tenth of the original volume. Before use it is diluted with a one half of one per cent solution of carbolic acid and passed through a Berkefelt filter.

Numerous attempts have been made by Koch, E. Klebs, and others to purify tuberculin. The addition of alcohol to tuberculin throws down a white flocculent powder which may be further purified by washing with alcohol. It is soluble in water and contains the active principles of tuberculin.

Klebs's *antiphthisin* and *tuberculocidin* are well-known representatives of such products. In the preparation of tuberculocidin, cultures on liquid media are allowed to macerate in the incubator for several months in order to extract the intracellular substances, and then precipitated with sodium-bismuth-iodid and alcohol.

Maragliano prepares a tuberculin by extracting the bodies of the bacilli with distilled water. The cultures are filtered, the bacilli washed, and macerated over a water bath at 85° C. for six days. The culture medium does not enter into the preparation.

The watery extract of Von Ruck is similar to the above. The washed

bacilli are, however, treated with alcohol and ether, pulverized, and then extracted with water at 50° C. for a longer period.

Tuberculol (Landmann) is prepared by making normal saline and glycerin extracts of pulverized tubercle bacilli at 40°, 50°, and 100° C., which are then combined and evaporated at 37° C., to small volume.

The new *tuberculins of Koch* are prepared from the bodies of virulent bacilli. T. A. (Tuberculin Alkaline) is made by digesting bacilli with a one tenth normal solution of caustic soda, then filtering. T. O. (Tuberculin Oberst) and T. R. (Tuberculin Rest) are prepared by triturating thoroughly tubercle bacilli which have been previously dried. Distilled water is added and the whole mixture put in a centrifugal machine. The top layer is removed and called T. O. The sediment is again dried, triturated, water added and centrifugalized, the operation being repeated until no residue is left. The product is called T. R. *Bacillen Emulsion* (B. E.) is Koch's most recent modification. It consists of finely pulverized virulent tubercle bacilli suspended in equal parts of water and glycerin.

Béraneck's tuberculin is made from cultures grown on bouillon containing no peptone. The bacilli are taken out by filtration and extracted with a ten-per-cent solution of orthophosphoric acid. The filtrate is evaporated to one tenth of its volume *in vacuo* and precipitated with alcohol, the precipitate and extract being then mixed in equal parts.

The Perlsucht tuberculin of Spengler is Koch's old tuberculin made from bovine cultures.

Von Behring has recently put out several products of the tubercle bacillus, more or less allied to tuberculin, definite descriptions of which are difficult to obtain. *Tuberculase* is an emulsion of the residue of tubercle bacilli after being extracted successively with alcohol, water, ten-per-cent solution of sodium chlorid, and other substances. The bacilli are further subjected to treatment with chloral hydrate. The use of tuberculase is restricted to cattle.

Tulase is used for man as well as animals. It is a clear, yellowish fluid, said to contain all the constituents of the tubercle bacillus.

Tulaselactin is a preparation of tulase in the form of a milky emulsion. When fresh it is said to have but slight tuberculin-reacting properties, but acquires them later through instability.

Various other preparations have been announced from time to time, all of which contain the same principle in greater or less quantity and more or less modified by the process of extraction.

Sources of Infection.—It has already been said that the tubercle bacillus is a strict parasite, and is not found outside of the animal body, except in places contaminated by morbid products of man and animals.

Man is the chief source of danger for man, and the sputum of the consumptive plays the most important part in the dissemination of the bacilli. Nuttall has estimated from a series of counts that a fairly well advanced consumptive spits out from one and a half to four and a third billion bacilli in twenty-four hours. It is evident that a single consumptive who is careless in his habits may be the means of endangering many people. The bacilli deposited on the streets in sputum soon lose their vitality through the action of light, air, etc., and the danger from this source has, no doubt, been exaggerated, though it must be recognized and guarded against. Sputum unquestionably retains its virulence for a longer time in dark and moist places, such as may be found in public conveyances, houses, etc. Rooms which have been occupied by consumptives may retain virulent bacilli for at least six weeks (Cornet). Cornet believes that a consumptive infects only a small area about him—30 to 50 cubic meters.

It is generally believed that the distribution of bacilli takes place through the drying and pulverization of sputum, which is then easily carried as dust by currents of air and inhaled or swallowed. Flügge considers the fine particles or droplets of sputum ejected during coughing, sneezing, and speaking as the chief source of infection. He found that an artificial spray remained suspended in the air for as much as five hours. It has been shown by other observers, experimenting by placing the *Bacillus prodigiosus* in the mouth, that during speaking and coughing the droplets were sent as much as 4 meters from the mouth, and by stronger currents of air even 30 meters. Heymann, employing an artificial spray of tubercle bacilli, found that the droplets remained suspended in the air for one and a half hours at most. He found that after falling to the floor the bacilli usually soon died. He obtained a fair number of positive results on the second and third days, and occasionally on the twelfth and even eighteenth days. It is impossible at present to estimate correctly the relative importance of these two sources of infection. Both must be recognized and guarded against.

Sputum is also disseminated through the habit of spitting into handkerchiefs, which soil the pocket into which they are placed. Drying and pulverization take place rapidly. Hands soiled with sputum also help in the spread of infection. Baldwin has shown that living tubercle bacilli are not infrequently present on the hands of tuberculous persons who are not careful in their habits. Kissing must also be mentioned as a possible source of infection.

The relation of bovine tuberculosis to human health has been the subject of much discussion, and is referred to elsewhere. It has been proved that the bovine tubercle bacillus is quite frequently found in

the lesions of children, and the bovine disease must be looked on as an important factor in the causation of tuberculosis in man.

Modes of Invasion.—*Heredity.*—The portal through which the tubercle bacillus gains entrance to the body has been the subject of much discussion as well as experimentation. The persistent belief in the hereditary nature of the disease has for a long time done much to obscure the observations of professional men and block progress in the eradication of the disease. True hereditary tuberculosis unquestionably occurs, but in a minimum number of cases. A careful review of the literature reveals less than twenty-five authentic cases in man, and while in cattle a much larger number have been observed, the percentage is still very low. Experimentally it has been produced through the semen, as well as through the placental circulation, so that the possibility must be admitted. Recent studies by Warthin and Cowie indicate that placental tuberculosis is, perhaps, more frequent than heretofore believed. If this is true, placental transmission is probably more frequent than it is now considered to be.

It has, however, been pointed out by Schmorl and Kockel, who made the first report on tuberculosis of the placenta, that the placental villi have a remarkable power to retain their integrity, even when embedded in tuberculous new growth. When the villi become tuberculous, thrombosis with occlusion occurs, as is the rule with blood-vessels elsewhere, and the supply of blood is cut off. Hence, as Cornet justly observes, the presence of tubercle bacilli in the placenta does not at all prove transmission to the fetus. Further evidence against the hereditary transmission of tuberculosis in man is found in the statistics of orphan asylums. As is well known, tuberculosis is a prime factor in creating the necessity for such institutions, yet all observers are practically in accord in stating that tuberculosis is rare among these children. Demme has observed in 36,148 patients in children's hospitals 1,932, or 5.3 per cent. with tuberculosis. Schnitzlein, who observed 613 children in an orphanage, 43.59 per cent of whom had lost one parent, and 6.86 per cent both parents, from tuberculosis, reports that since 1876 not a single death from the disease has taken place.

The study of mortality tables from all sources shows that tuberculosis during the first year of life is much less frequent than after this period, and it is very rare during the first few months of life. If infection occurs during intra-uterine life we would certainly find the incidence of tuberculosis during the first few months of life greatly in excess of what statistics show. The fact must be emphasized that children born of tuberculous parents, when removed from them soon after birth, enjoy a freedom from the disease which would be impossible if intra-uterine infection was not extremely uncommon. Experience

with cattle, in which uterine tuberculosis is known to be more frequent than in the human race, and the opportunity for hereditary transmission greater, is overwhelmingly in favor of the belief that postnatal infection is the important factor to be guarded against.

What is known as the Bang, or Danish system, which has proved after years of trial most efficient, is based on this fact. Calves born of tuberculous mothers are removed at once to barns free from contagion and reared on sterilized milk or milk from healthy cows. The results prove that even in cattle intra-uterine infection is rare. It may be said that while the possibility of hereditary transmission of tuberculosis must be admitted, it is so rare as to be practically negligible in the consideration of modes of contagion, and hygienic measures designed to combat the spread of the disease.

Wounds, etc.—A similar statement may be made in regard to other modes of infection which are sometimes met with clinically and have experimentally been proved possible. Among these may be mentioned accidental inoculation through wounds, the eye, the ear, and the genito-urinary organs. Wound infections are seen most often in those doing autopsies on the bodies of tuberculous men or animals. The formation of local tubercles at the site of inoculation without constitutional disturbance usually follows. They may heal under protective treatment, but sometimes require excision. There are on record, however, a certain number of cases, apparently well authenticated, in which the invasion went farther, causing general infection with involvement of the lungs and death. The reports of such cases must be studied carefully, in view of the long period of incubation in tuberculosis. It is not easy to prove that the wound infection was the cause of the subsequent pulmonary disease. In many cases it is probably a case of *post hoc,* not *propter hoc.* Laennec, who died of phthisis, attributed his disease to wound infection, but in view of the long time which elapsed between the inoculation and his death, it appears that he was mistaken.

Pulmonary Tuberculosis.—By far the most important question to be considered is the mode of invasion in pulmonary tuberculosis. The relation of the lungs to the external air, and the vast preponderance of pulmonary tuberculosis over other forms of the disease, naturally led to the belief that infection took place directly through the *respiratory tract.* This idea was strengthened by observations on the various forms of pneumonokoniosis seen in those whose occupations expose them to the constant breathing of air laden with particles of foreign matter.

At the present time belief in the respiratory mode of entrance is held by the majority of the medical profession, including many whose learning entitles their opinion to high consideration. On the other

hand, facts, both experimental and clinical, are constantly accumulating which prove that the digestive tract is an important, if not the most important, avenue of entry for the tubercle bacillus. As early as 1868 Chauveau showed that infection of cattle was readily produced by feeding, and since that time numerous experimenters have obtained positive results, often when only a single infected meal was given.

The matter was brought to the front by Koch, in his London address, 1901. In discussing the importance of bovine tuberculosis in relation to human health, he took the ground that infection through food could be assumed with certainty only when the primary lesion was located in the intestine, and on the claim that this was seldom the case, based his opinion as to the slight importance of guarding our food products.

In considering infection through the digestive tract, a question at once arises as to the correctness of the premise laid down by Koch, which assumes that the tubercle bacillus cannot enter the system through the intestinal wall without the production of a lesion at the point of entrance. It leaves out of consideration the possibility of infection through any other part of the alimentary tract, which should be taken to include the entire apparatus with which the food comes in contact, beginning with the mouth.

Mouth and Tongue, Palate and Gums.—Tuberculosis of the mouth, gums, palate, and tongue is rare, even as a secondary manifestation in advanced phthisis, when all these structures are constantly exposed to large quantities of sputum containing myriads of tubercle bacilli. Experimentally, infection of these tissues, with enlargement and caseation of the related glands, is fairly easily produced, but as primary avenues of entrance, under natural conditions, they play an insignificant part.

Tonsils.—The same cannot be said of the tonsils, which are not infrequently the seat of apparently primary tuberculosis, and constantly show scars, giant cells, and other changes attributable often to tuberculosis. By inoculation of guinea pigs Dieulafoy found tuberculosis of the tonsil in 15 of 96 cases. Latham, who was careful to use only the interior portions of the tonsil, in 45 consecutive autopsies on children from three months to thirteen years of age, found 7 which were tuberculous. Confirmatory results have been obtained by Baup, Friedmann, and other observers. The tonsils are very frequently tuberculous in persons who die of phthisis. Walsham found tubercles in 21 of 34 cases examined post-mortem, and in several he considered the lesion primary. Tubercle bacilli may be lodged in the tonsillar crypts and remain there a longer or shorter time without producing tuberculosis of the tonsil. The results of Dieulafoy have been severely criticised on this ground, and properly so, since he made no histologic examination of the tissues

used for inoculation. The work of Latham, with practically identical results, is not open to a similar objection.

The tonsils are composed of lymphoid tissue, and no doubt act, to a certain extent, like lymph glands in filtering out and retaining invading bacteria. Hence, while they may be overwhelmed, and become avenues of entrance for the tubercle bacillus, they certainly prevent systemic infection for some time. Their ability to resist tuberculous changes is remarkable.

FIG. 1.—TONGUE AND TONSILS OF SWINE INFECTED BY FEEDING TUBERCLE BACILLI. Extensive necrosis of tonsils, which apparently served as port of entry.

Experimentally, the susceptibility of the tonsil in some animals has been shown repeatedly. In a series of experiments at the laboratory of the State Livestock Sanitary Board of Pennsylvania on the comparative virulence of human and bovine tubercle bacilli, swine fed with pure cultures in every instance developed generalized tuberculosis with marked involvement of the tonsils, which were in most instances necrotic and ulcerated. The inspection of swine for tuberculosis by the United States Government is based on the fact, established by careful observation on many thousand animals, that the lymph glands of the neck show the primary lesion in the vast majority of cases (Figs. 1 and 2).

Pharynx, Esophagus.—Tuberculosis of the pharynx and esophagus is extremely rare under any circumstances, and as a primary infection is practically unknown. It is probable, however, that the intact mucous membrane of the pharynx does, at times, allow the passage of tubercle bacilli, which first make themselves known by the enlargement of the related lymphatic glands. Experimental evidence of this is very strong, though it is, of course, very difficult to place the exact point of entry. In the case of a monkey to whom the writer fed tubercle bacilli on banana, and who died of pulmonary tuberculosis, the glands of the neck

were enlarged and caseous, and no lesion of the tonsil was found, so it appeared certain that invasion had taken place through some part of the mouth or pharynx. The habit monkeys have of storing food in the lateral pockets of the mouth renders them peculiarly liable to infection through the mucous membrane of this region. Cornet has also produced experimental infection through the uninjured mucous membrane of the pharynx.

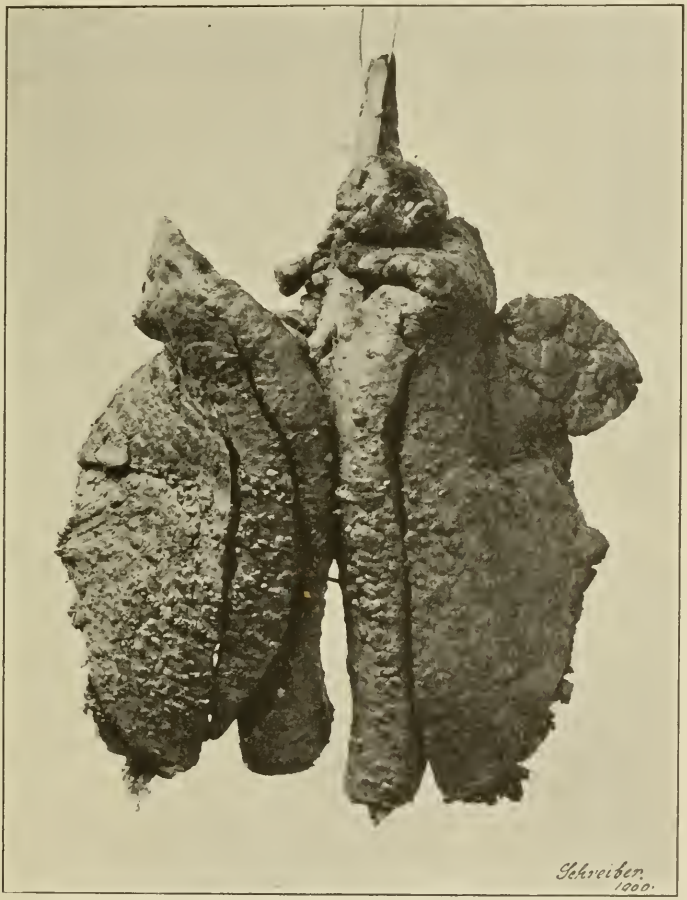

Fig. 2.—Lungs of Swine Infected by Feeding. The intestinal tract and mesenteric glands free from lesions. Infection probably through tonsils. See Fig. 1.

Stomach.—There is no evidence that infection ever takes place through the stomach. Tuberculous disease of the stomach is one of the rarest forms met with. The cause of this apparent immunity is not evident, but is attributed by some to the hydrochloric acid of the gastric

juice. Numerous experiments have been made to determine the action of the gastric juice on the tubercle bacillus (Falk, Wesener, Strauss and Wurtz, Frank and Fischer, Cadéac, etc.), both artificial and natural juice having been employed, by which it has been shown that the tubercle bacillus is able to survive intimate contact with gastric juice for at least as long as the ordinary digestive period. Clinical experience has also proved that infection of the intestine through swallowing sputum constantly takes place in phthisis. Further proof of the ability of the tubercle bacillus to resist for some hours the reaction of the gastric juice is found in experiments made to demonstrate the permeability of the intestinal mucosa (Dobroklonski, Nicolas and Descos, Ravenel, Calmette, etc.) in phthisis.

Intestine.—The frequency of intestinal tuberculosis in phthisis has just been mentioned. The autopsy reports of various pathologists state that it is found in from thirty to ninety per cent of cases. It is certain that in the great majority of these the actual lesion is secondary, and due to the swallowing of sputum laden with bacilli. This does not, however, in any way preclude the possibility that the pulmonary disease was caused in the first place by tubercle bacilli which gained access to the body through the intestine. In other words, the location of the primary lesion, on which so much stress has been laid, does not indicate with certainty the point of entrance of the invading organism.

In regard to primary intestinal tuberculosis—that is to say, those cases in which the oldest or primary lesion is found in the intestine itself or in the related glands—the reports from pathologists are contradictory. This is probably due, in part, to a difference in methods of examination and interpretation of results, and doubtless also, in part, to a real difference in the incidence of such cases in different communities, brought about by local customs and habits. In all reports a considerable number of cases are found in which it has been impossible to determine the site of the primary lesion. It is very difficult to draw entirely correct conclusions from many of the reports, since they have been made to demonstrate certain points, and do not give details as to other important features.

In England the pathologists who have studied tuberculosis in children are practically unanimous in considering that infection frequently takes place through the intestinal tract, since they find in the related glands evidences of the primary lesion. Still, Symes and Fisher, Shennan, Guthrie, Carr, Ashby, Batten, Kingsford, report on 1,560 autopsies, in which the primary lesion was found in the intestine 290 times, or 18.6 per cent of all cases.

In America, Northrup, Holt, and Bovaird report on 369 cases, all in New York or its environs, with 5 of intestinal origin, a little more

than 1 per cent. Holt contributed 119 of these autopsies, in none of which did he consider the intestine the seat of the primary lesion. It is interesting to note, however, that he found the mesenteric glands involved in 35 per cent and the intestine in 37 per cent of these cases.

Hand reports from the Children's Hospital of Philadelphia 115 autopsies on tuberculous children, with 10 cases (8.7 per cent) of primary intestinal localization and 1 of tonsillar invasion. In 29 cases the site of invasion could not be determined.

In this connection the work of Councilman, Mallory and Pearce is most instructive. They found tuberculosis in 35 of 220 children dead of diphtheria. In 18 of these the mesenteric lymph nodes were tuberculous, with involvement of the intestine 6 times; and in 7 cases the mesenteric glands were diseased without involvement of any other part of the body. In 13 cases (37.1 per cent) the infection evidently occurred through the digestive tract.

Statistics from Germany are most confusing and contradictory. Baginsky, in 5,448 autopsies on children, 1,468 of whom were tuberculous, found only 14 cases of primary intestinal involvement. In another series of 806 autopsies, 144 of which were tuberculous, he found only 6 in which he considered the intestinal lesion to be the oldest. A third series of figures by Baginsky, often quoted, gives the results of 933 cases of tuberculosis in children, in which he never found intestinal tuberculosis without involvement of the lungs and bronchial nodes. These figures are without value, as there is no indication of the site of the primary infection.

Biedert found only 16 cases of primary intestinal tuberculosis in 3,104 autopsies on children. Ganghofner, Koch, Heubner, Benda, von Hansemann, and others agree in regarding primary intestinal tuberculosis as comparatively infrequent. On the other hand, we have a mass of testimony from equally reliable observers which agrees very closely with the figures from England.

Hueppe, without giving statistics, says that "the number of cases (primary intestinal tuberculosis) may fairly be reckoned as between 25 and 35 per cent of all deaths in children from tuberculosis." Hof, in a systematic study of the autopsy records of the Pathological Institute at Kiel, found 2,697 cases of tuberculosis in adults, 159 (5.9 per cent) of which were primary in the intestine, while in 84.9 per cent the respiratory tract was primarily involved. In children there were 936 cases of tuberculosis, 235 (25.1 per cent) of which showed evidences of infection through the intestine, and 527 (56.2 per cent) respiratory infection. Wagener (Kiel), in 600 autopsies, 76 of which were on children, found primary intestinal tuberculosis in 16, or 21.1 per cent. Heller, in 711 fatal cases of diphtheria, found tuberculosis 140 times,

in 53 (37.8 per cent) of which the origin was primary in the intestine. In a later series of 230 autopsies, Heller found intestinal tuberculosis in 12 per cent of adults and 26 per cent of children.

Nebelthau, in 26 autopsies on tuberculous children, at the Halle Polyclinic, found that the infection was primary in the intestine in 5 (19.2 per cent), and in the respiratory tract in 9 (34.6 per cent), while in 12 (46.1 per cent) both tracts were infected. Kossel, in 14 children dead of other diseases, found tuberculosis of the bronchial glands 10 times, and of the mesenteric glands 4 times. In 22 children who died of tuberculosis, he found the disease confined to the intestine only once. Lubarsch, in 297 autopsies on children, found tuberculosis in 63, of which 14 (21.2 per cent) were primary in the alimentary tract.

Studies on the bodies of children who died of other diseases, such as those reported by Councilman, Mallory and Pearce, Heller, and Kossel, are particularly valuable in the determination of the avenue of entry for the tubercle bacillus. It is well known that in children tuberculosis tends to become generalized rapidly, and at autopsy it is frequently impossible to tell by what route the infection took place.

When death has come from other causes, the tuberculous lesion is usually localized, and often confined to the glands which are in relation to the point of invasion, hence the portal of entry can be determined with great certainty.

In a most masterly study Harbitz gives the following table of his own results obtained from 117 cases:

Primary in respiratory tract	48 cases,	41 per cent.
Primary in digestive tract	26 "	22.0 "
Primary in digestive or respiratory tract	24 "	20.5 "
General lymph-node tuberculosis	11 "	9.4 "
Doubtful, or other primary seats	8 "	6.8 "

For the sake of fairness, statistics have been given at some length in order that the reader may know the ground for the conclusions arrived at and be able to judge of their soundness. As stated before, however, the site of the primary lesion does not always indicate the point of entrance of the tubercle bacillus, and this is probably especially true of infection by way of the intestine, though it has been shown by numerous experimenters (Cornet, Dobroklonski, Desoubry and Porcher, Nicolas and Descos, Römer, Renshaw, Sidney Martin, Ravenel) that the mucous membrane of the various parts of the body can be penetrated by the tubercle bacillus without previous injury and without demonstrable lesion. This opinion is now very widely held by pathologists, owing to the extreme frequency with which various groups of glands are found

to be tuberculous, with no demonstrable lesion of the mucous surface which they drain. In many of the feeding experiments especial care

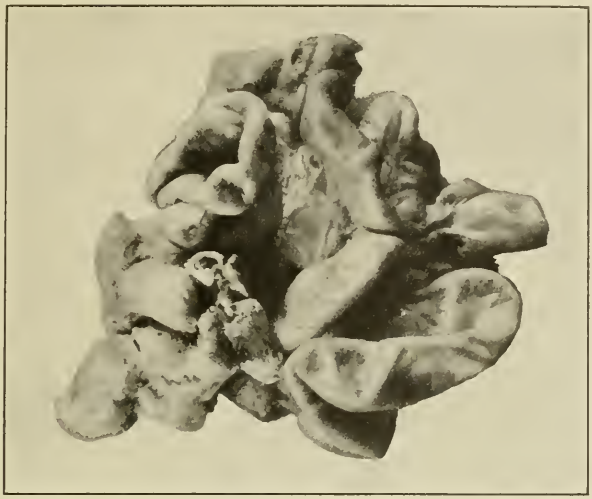

Fig. 3.

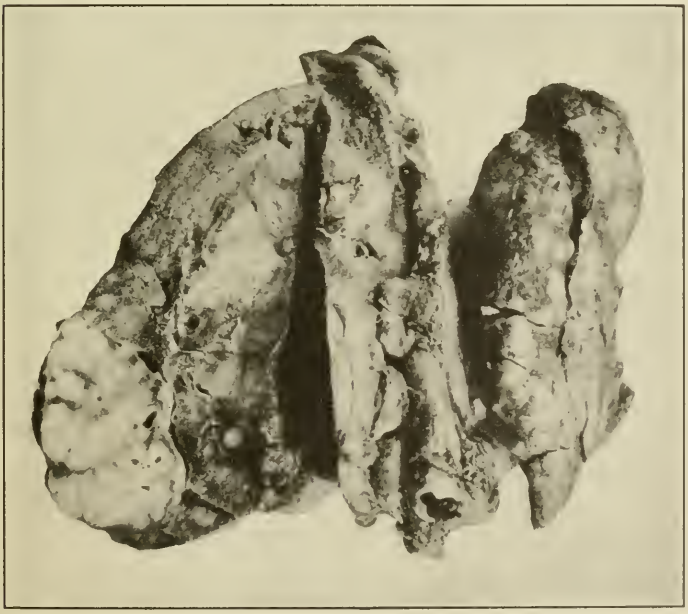

Fig. 4.

Figs. 3 and 4.—Tuberculosis of the Intestines and Lungs of a Monkey Fed with Tubercle Bacilli. (Probably pulmonary infection through intestines.)

has been taken to avoid injury of the alimentary tract, the bacilli having been mixed with milk given on bananas, etc. In some experiments a purge of castor oil was given to free the intestine of all rough matter it might have contained, and the animal fed on soft foods for a number of days before the infected meal was given (Figs. 3 and 4).

Harbitz considers it perfectly reasonable to believe that tubercle bacilli may pass through one or more groups of lymph nodes before becoming stationary and setting up inflammation, supporting this view by the results of certain feeding experiments, in which the thoracic glands have been found to be tuberculous without corresponding disease of those in the abdomen.

Entrance of tubercle bacilli and other organisms through the intestinal wall without demonstrable lesion has been proven repeatedly, beginning with the work of Dobroklonski, under Cornil, in 1890, who showed that the tubercle bacillus would quickly penetrate the healthy wall of the intestine in guinea pigs. Desoubry and Porcher, students of Nocard, showed in dogs that during the digestion of fats large numbers of bacteria were carried through the intestinal wall, and could be detected in the chyle. If food deprived of fat was given, few or even no bacteria were found in the chyle.

In feeding experiments conducted at the laboratory of the State Livestock Sanitary Board of Pennsylvania we often observed extensive tuberculosis of the lungs and thoracic glands in animals which showed slight or even no involvement of the intestine. In 1902–3, acting on the suggestion contained in the work of Desoubry and Porcher, the writer introduced into the stomachs of a number of dogs tubercle bacilli suspended in an emulsion of melted butter and warm water, using a stomach tube in order to avoid possible infection through the trachea. The dogs were killed after three and a half to four hours, during active digestion, and as much chyle as possible collected, together with the mesenteric glands, which were examined microscopically, and also inoculated into guinea pigs. Tubercle bacilli were demonstrated in abundance in eight out of ten experiments, proving that, during the digestion of fat, tubercle bacilli are carried rapidly through the healthy intestinal wall.

Römer, with von Behring, has shown that the tubercle bacillus, and even the anthrax bacillus, which is very much larger, passes through the normal intestinal mucosa of young guinea pigs readily. A single feeding with a minute quantity of tubercle bacilli frequently produced tuberculosis. In the infected animals the glands of the neck were always involved, and later there often developed a type of the disease usually regarded as the expression of an inhalation tuberculosis. Von Behring asserts that the origin of epidemiologic pulmonary tuberculosis in man,

and epizoötic pulmonary tuberculosis in cattle, is a primary intestinal infection taking place in early infancy.

The subject has recently been studied by Calmette and his fellow-workers at the Pasteur Institute of Lille, Guérin, Vansteenberghe, and Grysez. In numerous experiments they have found it impossible to produce anthracosis of the lungs even when the animals were compelled to breathe an atmosphere saturated with lampblack, provided the esophagus was closed. On the other hand, when lampblack was introduced into the stomach by means of a tube, or mixed with food, anthracosis of the lungs appeared rapidly. When tubercle bacilli, either dry or moist, were administered by inhalation, by intratracheal insufflation, or direct inoculation into the trachea, the bacilli never penetrated farther than the first branches of the bronchi. The introduction of tubercle bacilli into the stomach through a tube, in order to avoid all danger of respiratory infection, always produced tuberculosis rapidly.

They confirm the observation that tubercle bacilli readily penetrate the intestinal wall without leaving any lesion. They have traced the bacilli, and found that as soon as they reach the chyle vessels they are taken up by leucocytes, which from this time on act as carriers, and convey them to the related gland, where they are retained for a longer or shorter time, reaching finally the thoracic duct, which, in turn, pours them into the pulmonary circulation. They are then arrested in the fine capillaries of the lung.

If the leucocyte has taken up many bacilli it soon loses its motility and acts like a toxic foreign body, against which the cells of the vessel wall react, and englobement by one of the cells (endothelial macrophages) takes place, producing the primitive tubercle, which is always intravascular. On the other hand, leucocytes which have englobed only one or two bacilli retain for a long time their motility, and when arrested in the capillaries penetrate the vessel walls by diapedesis, reaching the lymphatic channels, which carry them to the bronchial or mediastinal glands. Here they may die, and the contained bacilli produce lesions; or else again reach the thoracic duct and the circulation, by which they are carried to distant parts of the body, being finally killed by the poisons of the bacilli and arrested in the capillaries of some organ or tissue, perhaps the meninges, the kidney, the joints, etc., where a primitive tubercle is formed.

In young animals the mesenteric glands retain the bacilli and the leucocytes which contain them for some time, and the glands enlarge in proportion to the intensity of the infection, the lungs becoming secondarily involved. In adult animals, on the contrary, the glands do not retain the bacilli nearly so long, and they can be found in the lungs twenty-four hours after their introduction into the stomach. This de-

pends on the minute anatomy of the glands, which are much more permeable in adult than in young animals.

Calmette concludes that pulmonary tuberculosis acquired at any age may be due to recent intestinal infection. More recently Schlossmann and Engel have shown that when tubercle bacilli in milk or cream are injected into the stomachs of young guinea pigs through an incision in the abdominal wall they reach the lung in a few hours, as proven by killing the animal and inoculating others with portions of the lung.

Ravenel and Reichel have repeated the work of Schlossmann, and have obtained confirmatory results. Fifty guinea pigs, from sixteen hours to two weeks old, were inoculated directly into the stomach. They were killed from four to twenty-four hours later, and their lungs inoculated into other guinea pigs. The results were positive in 28, or fifty-six per cent, the larger number of these being in the younger animals. Thirty of these pigs were killed after four, five, and six hours, 16 giving positive evidence that in this short time tubercle bacilli had passed from the stomach to the lungs in sufficient numbers to produce tuberculosis in animals inoculated with these organs.

Oberwarth and Rabinowitsch have given conclusive evidence on this matter, employing young swine. They established a gastric fistula in these animals, and then closed the esophagus. Tubercle bacilli introduced into the stomach were shown to have reached the blood and the lungs within twenty-two hours.

Most valuable contributory evidence of the importance of infection through the digestive tract is given in the Second Interim Report of the Royal (British) Commission on Tuberculosis (Part I, 1907). This commission, appointed to study the relation of bovine tuberculosis to the human disease, isolated and examined 60 cultures of tubercle bacillus from human beings. Fourteen cultures proved to be the bovine bacillus —1 obtained from sputum, 3 from cervical glands removed at operation, and 10 from the lesions of primary intestinal tuberculosis in children. Similar findings have been reported by Ravenel, de Schweinitz, Theobald Smith, the German Commission of the Imperial Health Office, and others.

The opportunities for the inhalation of bovine tubercle bacilli by human beings are slight at best, except, perhaps, for persons who habitually care for cattle, and compared to those for ingestion they are insignificant. There is almost no possibility, in the case of children, for the inhalation of bovine bacilli, even if we admit that the aspiration of particles of food may occur. We are therefore forced to conclude that in those cases from which the bovine bacillus has been isolated the infection has taken place through the digestive tract.

Respiratory Infection.—Experimental demonstration of the possibility of infection through inhalation was first given by Tappeiner in 1877,

who made dogs breathe air laden with dried and pulverized sputum. In later experiments by Koch, Cornet, Gebhardt, and others, pure cultures of the tubercle bacilli were employed. Many negative results were obtained by other experimenters, such as de Thoma, Celli and Guarnieri, Cadéac and Malet. Cornet believed these failures due to the fact that conditions similar to those of natural infection were not obtained. In 1898 he placed 48 guinea pigs in a large room, at different heights above the floor and in different parts of the room. Dried sputum was placed on the carpet and broken up and distributed by sweeping. Of the 48 guinea pigs, 47 contracted tuberculosis of the bronchial glands and lungs, with partial cavity formation. This work, in common with most inhalation experiments, is open to the very grave objection that no attempt was made to close the esophagus, and it is certain that some of the bacillus-laden dust was swallowed.

Nenninger has, however, shown that when rabbits are forced to breathe air laden with the *Bacillus prodigiosus*, cultures can be recovered from the finest bronchi. Similar observations have been made by Paul, Fischer, Beitzke, etc. Findel, working with Flügge, has infected dogs and a calf by blowing a spray of bovine tubercle bacilli into the trachea, which had been previously opened. At autopsy, tuberculosis of the lungs was found, while the tonsils, cervical, retropharyngeal, and mesenteric glands were free from disease, both macroscopic and microscopic. Schultze has repeated some of Calmette's experiments, and though after feeding pigment it was found only in the lungs, he believes that it reached them through aspiration. He does not consider that the use of a stomach tube excludes the possibility of inhalation. In a rabbit he introduced pigment into the stomach through a fistula for two months, and at death was unable to find any deposit in the lungs.

Spronk also believes that the aspiration of food particles frequently takes place even when a stomach tube is employed. Under his direction Nieuwenhuyse carried out feeding experiments similar to those of Vansteenberghe and Grysez, but in only one animal was the pigment recovered in the lung, and this was believed to be due to aspiration.

In view of the evidence at hand, and which is constantly accumulating, it may be said that infection through the alimentary tract is not only possible, but unquestionably occurs in a large proportion of cases. In children, especially, it occupies a position almost, if not quite, as important as respiratory infection. It must not be understood that the source of such infection is always food. Dust which reaches the upper air passages and mouth is constantly swallowed with the saliva and nasal secretion. The frequency with which the bovine tubercle bacillus has been found in children shows, however, that food is often responsible for the infection.

ADDENDA

Summary of Bacteriological Work Presented at the International Congress, Washington, D. C.

Viability of the Tubercle Bacillus.—Dr. M. J. Rosenau has carried out extensive experiments on the viability of the tubercle bacillus. He points out the difficulty of telling dead from living tubercle bacilli by inoculation, owing to the production of tubercles by the dead germ, and shows the necessity of making secondary inoculations in all doubtful cases. The tubercle bacillus is killed surely by a temperature of 60° C. continued for twenty minutes.

Types of the Tubercle Bacillus.—Professor Arloing is a stanch believer in the unity of the tubercle bacillus. All the variations in virulence and morphology are simply changes brought about by environment. The human bacilli, as obtained from different types of the disease, show marked variation in virulence. This variation is as marked as is the difference usually found between the human bacilli and the bovine bacilli. He has modified both bovine and human bacilli by special methods of culture, showing that it is possible in this way to lower or increase the virulence. He has even produced types closely allied to the avian bacillus. From the standpoint of hygiene his studies emphasize the importance of guarding against all types of the tubercle virus, whatever may be the origin.

Investigations into the Relations between Human and Bovine Tuberculosis.—Profs. J. Fibiger and C. O. Jensen have made an elaborate investigation on this point. The authors hold strongly to the unity of the tubercle bacillus, and do not admit a sharp distinction between the bacilli usually spoken of as human and bovine. A number of cultures show transitional forms having some of the characteristics of the bovine and others of the human type. They believe strongly in the danger to mankind from bovine infection. Dr. Nathan Raw admits of the differentiation of the tubercle bacillus into two types, the human and the bovine. He holds strongly to the belief that the bovine bacillus is highly virulent for mankind, and produces certain types of tuberculosis as a rule. These are peritonitis, lymphadenitis, acute miliary tuberculosis, meningitis, arthritis, and lupus. The human type of the tubercle bacillus produces usually pulmonary tuberculosis, ulceration of the intestines, and laryngitis. He believes that an infection by the human type protects against bovine infection, and vice versa. In his practice he uses the tuberculins in accordance with this view. He has treated about two hundred cases of tuberculosis with the various tuberculins, and is greatly encouraged.

Intertransmissibility of Tuberculosis.—Dr. Charles F. Dawson holds strongly to the danger to mankind of bovine infection. The wide range of pathogenic power of the bovine tubercle bacillus makes it practically certain that it is pathogenic for man also. The infection comes usually from ingesting the products of tuberculous cattle, infection taking place through the alimentary canal.

Susceptibility of Cattle to the Surgical Forms of Tuberculosis.—Susceptibility of cattle to the surgical forms of tuberculosis has been studied by Dr. R. R. Dinwiddie. Intraperitoneal inoculations of material obtained from two cases of glandular tuberculosis, one of arthritis, and one of genito-urinary tuberculosis, were made in yearlings without effect. The writer has believed, with Dr. Raw, that certain forms of tuberculosis are of bovine origin, which has not been confirmed by his experiments.

Dr. Charles W. Duval has studied the tubercle bacilli isolated directly from the tissues of four human bodies, the disease in each case beginning with cervical adenitis, and death occurring in from six to eight weeks after the first symptoms. All cases showed primary lesions in the cervical region and acute general miliary tuberculosis. Of the four cultures one was human in character and one bovine, the two others representing intermediate forms, one approaching bovine and the other the avian type. Inoculations of animals with these led him to suspect the possible relation between Hodgkin's disease and such bacilli.

Drs. J. N. Davalos and J. Cartaya have examined a series of cases in human beings and failed to isolate the bovine bacillus from any of them. Number of cases not given.

Dr. Hidego Noguchi has shown that oleate soaps have the power of modifying the virulence of tubercle bacilli. According to the concentration used the virulence of the tubercle bacilli is so modified as to infect guinea pigs slightly or not at all. The guinea pigs which failed to develop tuberculous lesions following the inoculation acquired a definite degree of immunity to virulent bacilli. The oleate soaps showed the same effect on tubercle bacilli cultures, very small amounts inhibiting the growth or preventing it completely. The bactericidal effect of these soaps is much greater than that of the component parts used separately. He believes that those substances derived by autolysis from organs which are actively bactericidal contain lipoids, and that soaps formed during autolysis are important, if not the chief, factors in this bactericidal action.

Drs. N. Janeso and A. Elfer, from an extensive series of studies made on 93 tuberculous persons, 11 bovines, 1 pig, and 18 chickens, find that all types of bacillus isolated may be divided rather sharply into three groups—human, bovine, and avian. Among the cultures derived

from human beings, one showed all the characteristics of the avian type, the others all belonging to the human type. The bacillus obtained from the pig belonged to the bovine type. They find, however, that among cultures which can be placed in one category or the other, there are marked differences in many of their characteristics and in virulence. They obtained a number of cultures from human beings which produced death in rabbits, though, as a rule, their human cultures showed very slight virulence for rabbits. Cultures obtained from the different organs of one and the same individual also showed marked variation in important characteristics. They find that it is relatively easy to modify the characteristics of the various acid-fast organisms isolated, especially their pathogenicity. They have not, however, succeeded in giving them any specific properties, and believe that in nature the more important groups tend to become more and more clearly differentiated, one from the other.

Courmont (J.) and Lesieur show that infection may be produced in calves, rabbits, and guinea pigs through the uninjured skin if the culture used is sufficiently virulent. Inoculations with sputum are not as effective as those made with pure cultures. In one third of the infections the skin shows no trace of the passage of bacilli, in one third we find slight indurations or small scabs, and in one third warty tubercles are found. The skin, therefore, does not form an impossible barrier to the tubercle bacillus, even when apparently intact. Abrasions and minor injuries may form portals of entry for distant lesions. The absence of a local lesion does not disprove this mode of infection. In rabbits we may have a pulmonary lesion resulting from percutaneous infection, a marked example of a lesion originating at a point far removed from the point of entry of the bacillus.

Carl Fränkel also produced infection in guinea pigs through the apparently intact skin. Dr. Isador Spitzstein has performed similar experiments with entirely negative results, and concludes that if percutaneous infection is possible at all it is the most unfavorable route for the tubercle bacillus to enter the body.

Cultural Characteristics of Tubercle Bacilli.—Dr. Johann von Szabòky finds that agar made from lung tissue forms the best medium for growth of the tubercle bacillus. The next best media are sputum-agar, sputum-lung-agar, and tuberculous lung-agar. The best reaction of media varies with the media. In general feebly acid media seem best. Very moist media, like lung-agar, gave best results, and dry media least good. The tubercle bacillus changes the reaction of the medium during growth. Most media showed first an alkaline reaction, which changed to acid, and again to alkaline. Agar made with somatose showed changes the exact reverse of this.

Chemistry of Tubercle Bacilli.—Dr. V. C. Vaughan finds that the tubercle bacillus after being freed from substances soluble in ether and alcohol, may be split into two portions by an alcoholic solution of alkali—a poisonous and nonpoisonous. The poisonous portion kills animals after a few months in doses of 75 to 100 mgm. The nonpoisonous portion sensitizes animals to the whole bacillus. It is used in the treatment of human tuberculosis, but it is too early to say whether or not it is better for this purpose than old tuberculin.

Chamber for Handling Dried Tubercle Bacilli.—Dr. A. P. Hitchens has devised a chamber for handling dried tubercle bacilli with perfect safety. It consists essentially of a tight chamber, provided with a suction pump and a cotton filter for the admission of air. Manipulation is carried out by means of rubber gauntlets sealed into the wall of the chamber, and the pump is operated during use. After use the pump is cut off and the filter box closed, formalin and lime or permanganate of potash, which were placed in the chamber before use, are mixed, and complete disinfection takes place. It may be used for handling other dry biological products.

Action of Diffused Light on Tubercle Bacilli.—John Weinzirl, Ph.D., finds that direct sunlight kills the tubercle bacillus in from two to ten minutes. Diffused light always killed tubercle bacilli within one week, sometimes in twenty-four hours. He lays stress on the point that no medium which absorbs light shall be placed between the bacilli and the light. Moist cultures were killed sooner than dry ones. It seems certain that light in dwellings, etc., is a valuable germicide.

Flies as Agents in Dissemination of Tubercle Bacilli.—Dr. Ch. André finds that flies are active agents in the spread of tubercle bacilli, polluting foodstuffs with bacilli adhering to feet after contact with sputum. After feeding on tuberculous sputum they evacuate bacilli within six hours, and some may be found in feces as long as five days after. Food thus polluted by flies will infect guinea pigs. Flies caught in hospital wards produce tuberculosis in guinea pigs. It is therefore of prime importance to disinfect sputum and feces promptly and to protect them from flies. Foods must also be protected and flies destroyed as far as possible.

The transmissibility of bovine tuberculosis to human beings was discussed at a *conference in camera*. The trend of the discussion was put into the hands of Koch, who limited it to two questions—first, the frequency of intestinal tuberculosis, and second, the occurrence of the bovine bacillus in pulmonary consumption.

In 1901 Koch said "human tuberculosis differs from bovine and cannot be transmitted to cattle," and further that "if transmission from cattle to man ever took place, it was so rare that he did not deem it

advisable to take any measures against it." The disproof of the first statement was so easy that observers all over the world soon gave numerous cases showing its error. Many private workers, as well as a British Royal Commission and a German Imperial Commission, soon showed the fallacy of these two statements, as has been pointed out in the body of this book.

Koch's ground having been shown to be untenable, even by a commission of which he was a member, he has now shifted, and makes the claim that pulmonary consumption is not caused by the bovine germ. At the conference in question he made the following statement, "I desire to put myself again on record by saying that I have never denied that bovine tuberculosis may occur in human beings," a statement which was repeated more than once. His general conclusion, as given in his paper before the Congress, was that our preventive measures must, therefore, "be directed primarily against the human disease," an opinion which is not by any means original with Koch, but is held all over the world, even by those men who believe most firmly in the danger to mankind from cattle tuberculosis.

In reply to Koch's demand that cases of pulmonary tuberculosis due to the bovine tuberculosis be brought forward, Professor Arloing at once gave the history of a most typical case. The British Royal Commission also reported the finding of bovine bacilli in the sputum of a consumptive. It will be remembered also that the German Commission found the bovine bacillus in a case of miliary tuberculosis of the lung, though Professor Koch now denies that this case bears on the subject at all—a method of reasoning which cannot be understood by the ordinary mind. In miliary tuberculosis a person usually dies before the tubercles soften and the case becomes an open one, as is well known, but infection of the lung from the intestinal tract is proven by a case of miliary tuberculosis just as much as though the case were one of ordinary consumption. In fact, miliary tuberculosis is believed to be the result of a large number of bacilli entering the blood stream at one time. The evidence then is strong that in such a case the number of bacilli gaining entrance to the system from the intestinal tract is very large.

Taking up the second point, in regard to the rare occurrence of primary intestinal tuberculosis, Koch quoted at length from Flügge. He was well answered by Professor Fibiger, of Copenhagen, who, while acknowledging the figures quoted from Orth, Baginsky, and others as having been correct for the year 1901, called attention to the fact that, without exception, these same men had in more recent work found a greatly increased number of such cases. For example, Benda, who in 1903 stated that he had found only 2 or 3 cases during some eighteen

months, in 1905 said that the frequency of this form of tuberculosis was greater than he originally thought. Orth, who in 1904, during a period of fifteen months, reported 2 cases among 33 children, in 1905 during twenty-two months reported 6 cases among 77 children. Baginsky, who in 1901 had not observed a single case of primary intestinal tuberculosis, found 6 cases among 144 children in 1902, and 30 cases among 389 children in 1905. Even these figures do not reach those given by Heller, Hof, von Wagener, Edens, and others.

One of two conclusions is obvious, either that these pathologists are finding more intestinal tuberculosis since their attention has been directed to it, or else there has been a great increase in this form of disease. Has this been brought about through carelessness in the use of milk from tuberculous cattle, since Koch has publicly announced that there was little or no danger from such use?

CHAPTER II

TUBERCLE AND MORBID ANATOMY

(General and Pulmonary Tuberculosis)

By LUDVIG HEKTOEN

HISTOGENESIS AND FATE

Tuberculosis is the result of the activities of the tubercle bacillus, which arouses in the body various reactive changes. Anatomically, tuberculosis manifests itself most characteristically and most commonly by the development of avascular cellular masses or tubercles (Baillie, 1794; Bayle, 1810), but it also may appear in other forms, more particularly as diffuse granulation tissue and as exudative inflammations. The designation "tuberculous" is applicable to all the changes caused by the tubercle bacillus, no matter whether tubercles are present or not.

Origin of Tubercle.—The tubercle is produced primarily by multiplication of the fixed cells, especially of connective tissue and of capillary endothelium at the site of the localization of the microbes.

The exact mode of action whereby this cellular proliferation is started has not yet been explained with convincing clearness, but various interpretations have been offered. Perhaps the most widely accepted explanation is that by Weigert, who regarded the cellular processes as essentially secondary to "injury" to cells and to intercellular substance by an immediate action of the bacillus. In most tissues the obtainable morphologic indications of such direct injury are not very striking; in tuberculosis of the placenta, however, Warthin ('07) finds unmistakable evidence of primary chemico-toxic action by the tubercle bacillus in the form of minute areas of necrosis, about which typical tubercles subsequently develop.

As a rule the first definite result of the invasion of many tissues by tubercle bacilli has been found to be (Baumgarten, '85) swelling and mitotic division of the fixed cells, which usually arrange themselves in a somewhat radiating manner about the bacilli, some of which soon appear within the cells. Because the cells may present rounded and polygonal bodies with vesicular nuclei, and appear to be connected with one another, Virchow designated them as "epithelial" cells, and they

are now commonly described as *epithelioid*. As the epithelioid cells of tubercles in most cases represent proliferative connective-tissue cells and endothelial cells, they correspond in every way to the fibroblasts in non-tuberculous inflammatory processes.

In parenchymatous organs tubercle formation is commonly associated with evidences, in the form of mitotic figures, of active multiplication of the specific cells of the parenchyma. This is seen both in the hepatic cells and in the epithelium of the bile ducts, in the neighborhood of developing tubercles in the liver, and in the epithelium of the uriniferous tubules about renal tubercles. It cannot be said, however, that it has been satisfactorily established that the derivatives of such cells regularly become constituent elements of tubercles. When tubercles develop in the neighborhood of epithelial cells—i. e., in the skin or mucous membranes—these may also increase in number and volume and undergo other changes, but without entering into the real structure of the tubercle.

The occurrence of typical tubercles in the midst of fibrinous exudates, without any direct connection with tissues, is urged as proof of the correctness of the view that tubercles develop wholly from emigrated leucocytes which may form both the epithelioid and other cells. It must be acknowledged that many tubercles in exudates can be formed only from cells with spontaneous motion. Young connective-tissue cells possess this faculty, however, and there is no good reason known why they may not wander out into fibrinous exudate in response to positive chemotaxis, and aggregate about tubercle bacilli at the same time as lymphocytes and leucocytes gather about and perhaps invade the growth.

Frequently, but not always, multinuclear giant cells form a conspicuous element in tubercles, even at an early stage. Much thought has been given to the explanation of giant cells, and at present two modes of formation are generally accepted. Probably rapid, commonly amitotic nuclear division or fragmentation, unaccompanied with corresponding division of the cells, is regarded as the more important. The failure of the cell to divide is ascribed by Baumgarten and Weigert to local necrotic or retrogressive changes in the cell body. It is also believed that giant cells form by the fusion of several adjacent cells; on account of the large number of nuclei often present, it has been suggested that in this case also there may be rapid nuclear division.

The typical tuberculous giant cell (Langhans, '68) sends out many branching processes and contains numerous oval, vesicular nuclei which are arranged more or less regularly or semicircularly at the periphery or massed together in one or two places. The anuclear part of the cell commonly shows evidences of necrobiosis, which is ascribed to the action of bacilli taken up by the cell.

A large amount of discussion has been given to the nature and significance of the giant cells of tuberculosis. Baumgarten, Weigert, and others have held that the giant cell is an element that is on its way to destruction from the very first and that it fails to divide because of the necrobiotic action of the bacilli it usually harbors. Metchnikoff, on the contrary, has championed the view, which now is more generally accepted, namely, that the giant cells of tuberculosis, like multinuclear plasmodial masses in general, begin their existence as active phagocytes. The fact that they are often destroyed has not changed this conception because this fate they suffer in common with all the cells in active and progressive tuberculosis. Among the indications that the giant cells are active phagocytes, at least at first, may be mentioned the occurrence within them of disintegrating and disintegrated bacilli. Koch was the first to point this out. In certain animals (*Spermophilus guttatus*, Algerian rat) Metchnikoff, and also Welcker, note calcareous and also ferruginous incrustation of what they regard as bacilli within giant cells in experimental tubercles, and Metchnikoff thinks that calcium salts and other substances are laid down by the giant cell itself in the reaction against the bacillus. Calcareous concretions, the exact nature of which is not clear (bacilli, elastic fibers?), also occur in giant cells in human tuberculous lesions. That the giant cells are not merely retrogressive structures is shown by their power under certain conditions to subdivide into cells that develop further.

True giant cells may be simulated by cross sections of hyaline thrombi in capillaries or minute vessels, with confluence of the endothelial cells. This is not a real giant cell; as a rule it is a circular body with smooth, definite outlines, and the study of serial sections may be necessary in order to determine its real nature and origin.

Sooner or later leucocytes in variable numbers gather at the periphery of the newly formed nodule and contribute to its enlargement. These cells are mostly small, mononuclear, round cells (lymphocytes), and correspond to the small round cells in simple inflammatory infiltrations (Maximow's "polyblasts," Marchand's "leukocytoids"). In many cases they may crowd into the tubercle and force the epithelioid cells apart (lymphoid tubercle); in other cases they may be present in very small numbers. Later still, especially when degenerative changes occur, polymorphonuclear cells may accumulate, sometimes in such numbers that the tubercles appear surrounded and invaded by purulent infiltration. It seems that the greater the number of bacilli, the more marked the inflammatory changes; whereas the slower the growth, and the fewer the bacilli the more numerous will be the epithelioid and giant cells.

At the same time, as there is migration of leucocytes, there is also

more or less serous exudation into the newly formed nodule. The amount of fibrin in tubercles—coagulable inflammatory exudate—is subject to great variation even in the same organ, and is dependent on the degree of injury to the blood-vessels, which in turn may be determined by the number, relative virulence, and location of the invading bacilli. Tubercles also occur without any demonstrable fibrin. The slower the development of the changes, because of relatively low virulence on the part of the bacilli or because of relatively greater resistance on the part of the tissue, the more marked the proliferative as distinguished from the exudative processes in the tuberculous lesion (Orth).

The intercellular fibrillar framework, which is demonstrable in all tubercles but, as a rule, most apparent in the margins, is known as the reticulum. It is an essential, preformed constituent, and not, as sometimes stated, the result of the action of fixing solutions. This reticulum is derived, at least in part, from fibrillation and rarefaction of the ground substance of the tissue in which the tubercle forms, the proliferating cells forcing the fibers apart until they become drawn out and thin in places, perhaps destroyed. (The elastic fibers in the old tissue disappear.) Then, too, the new cells composing the tubercle often send out long interlacing processes which surround the cells; this is especially true of the giant cells, the processes of which have been likened to spider's feet.

It is worthy of special emphasis that not only are new vessels not formed in tubercles, but also that the preëxisting vessels at the site of developing tubercles commonly undergo obliteration.

At the height of its progressive development, when the purely proliferative changes predominate, the tubercle forms a small, grayish, translucent nodule, the *granulation tuberculeuse* of Bayle and Laennec, the simple tubercle of Virchow and others, and the "granulation-tuberculosis" of von Behring. Commonly likened in size to that of a millet seed, it is in reality smaller (submiliary), as emphasized long ago by Virchow and more recently by von Behring. Sooner or later certain retrogressive changes may occur in consequence of which the tubercle becomes somewhat larger, opaque, whitish, yellowish-white or grayish-white (Laennec's miliary tubercle). This is caseation.

Tuberculous Granulation Tissue.—In addition to the formation of tubercles, the invasion of tissues by tubercle bacilli may result in the development of a diffuse, vascular granulation tissue which is distinguished by the presence within it of the specific bacillus, by occasional giant cells and tubercles, and by a tendency to retrogressive changes or caseation. This form of reaction on the part of the tissues occurs mostly when large numbers of bacilli and their products are brought into contact with extensive surfaces, as occurs when numerous bacilli are excreted by the

kidneys or when serous membranes are bathed by exudate rich in bacilli.

Tuberculous Exudative Inflammation.—The tubercle bacillus is capable also, as are its products, of causing diffuse typical inflammation with serous, fibrinous, or purulent exudation. Thus there are certain forms of tuberculous leptomeningitis in which there is a copious seropurulent or purulofibrinous exudate, without much, if any, tubercle formation. And in the lungs especially pure exudative tuberculous inflammations may occur without the characteristic tuberculous proliferations. Laennec was the first to include this form of pneumonia with tuberculosis. (See Pulmonary Tuberculosis.)

Tuberculous peritonitis, pleuritis, pericarditis, and synovitis are often marked by the predominance of the exudative processes. In such exudates the predominating cells are mononuclear cells. In many cases there may be a mixed infection. In the so-called tuberculous cold abscess the material in reality is not pus, as ordinarily understood, but rather a *débris* of necrotic cells and softened caseous material. Undoubtedly the products of tubercle bacilli can induce true suppuration, because tuberculin, according to Koch, is an excellent agent for the production of suppuration experimentally.

The tuberculous process begins with the formation of minute foci which arise either singly or, in case of several foci of infection, in simultaneous crops. As the bacilli multiply new foci may arise. Commonly the tissue about, even in the case of the typical tubercle, presents more or less inflammatory reaction in the form of congestion, exudation, cellular immigration, and proliferation. In this way develop foci, often nodular, especially on flat surfaces, and of varying extent in the congested grayish-red tissue of which the characteristic tubercles are detected more or less readily with the naked eye as minute grayish or grayish-yellow nodules. Now if the infection is arrested promptly almost ideal healing may be accomplished. But if the infection spreads into the adjacent tissue, and this is the more common occurrence, then the original focus enlarges and extends as the reactive phenomena continue; sooner or later caseation takes place, perhaps with softening and the growth of fibrous tissue, and in this way arise chronic tuberculous foci and caseous masses, the morbid anatomy of which is best described in connection with tuberculosis of the different organs.

Caseation.—All tuberculous formations—tubercles, diffuse granulation tissue, and exudates—sooner or later undergo the peculiar form of necrosis termed caseation. Dead caseous tissue has an appearance quite similar to that of cheese. In caseation the cells lose their outlines, become irregular, refuse to stain, and are finally converted into struc-

tureless masses and detritus (Fig. 5). Wells ('07) points out that caseous matter, like cheese, is a mixture of coagulated proteid and finely divided fat, so that the reasons for the gross resemblance of caseous ma-

Fig. 5.—Tubercle in Lung Tissue. Surrounding tissue showing only slight inflammatory changes; caseous center of tubercle; in periphery infiltration with round cells and several giant cells. (From Karg and Schmorl.)

terial to cheese is quite apparent. The proteid caseous material is almost wholly coagulated proteid, from which the products of nuclear disintegration have disappeared. Caseation differs from simple coagulation necrosis by the presence of a large amount of fat.

The cause of the coagulation in caseous necrosis is not clear. Wells suggests that it may be the same as in anemic infarcts, inasmuch as tuberculous tissues, as a rule, are decidedly anemic. It is possible that the tubercle bacillus produces substances which coagulate proteids, and Auclair claims that the fatty substance that can be extracted from tubercle bacilli by chloroform is the cause of caseation.

The amount of fat in caseous material is large. In material from

tuberculous bovine lymph nodes, Wells found 22.7 to 23.9 per cent of the organic material soluble in alcohol and ether. The fatty substances may be derived from disintegrated cells, and the fact that in microscopic sections most of the fat is found in the periphery of caseous areas suggests that fat passes in from outside. A certain though small amount of fat is probably derived from the bodies of the tubercle bacilli.

The persistence of caseous areas for a long time indicates that the autolytic enzymes are destroyed early. Leucocytes are not attracted by ordinary caseous material, but when softening occurs from mixed infection, chemotactic substances develop and leucocytes enter freely.

In the earlier stages caseation is associated with the appearance of firmly coagulated substances between the cells, evidently derived from the blood and called "fibrinoid" by Schmaus and Albrecht because it bears resemblance to fibrin. This substance does not react with the Weigert stain for fibrin, but stains yellow with Van Gieson's stain. The presence of this fibrinoid substance is probably one reason for the firmness and dryness of caseous material.

In tuberculosis caseation begins centrally and progresses peripherally. In stained preparations the caseous parts are characterized by the absence of staining. At the border of advancing caseation the nuclei present the appearances characteristic of karyorrhexis, and numerous chromatin splinters occur. In tuberculous granulation tissue caseation often spreads uniformly, so that large superficial patches are found as seen often in tuberculosis of the genito-urinary tract.

Tuberculous exudates also undergo caseation. When the exudate contains cells these are first converted into caseous detritus, whereas the fibrin persists for some time. In this way caseous hepatization in the lungs may show complete caseation of the central part of the contents of the alveoli, while the peripheral fibrinous parts of the exudate remain intact. Sooner or later the fibrin also loses its typical staining reaction and becomes transformed into caseous material, the process extending even to the alveolar walls, the elastic fibers of which, however, resist the process after all other structures have succumbed, so that it is not uncommon to find well-preserved, elastic framework in parts of the lung that have undergone so complete caseation that not a single nucleus, cell body, or fibrin thread is visible.

Caseous foci may become calcified. At first the calcareous matter, according to Wells ('07), appears as small granules which later may coalesce into larger masses and concretions. Old caseous and calcified masses are generally surrounded by more or less sclerotic connective-tissue capsules, which develop principally from the cells in the vicinity rather than from the tuberculous cells themselves, which, however, may take some part in this formation. Caseous matter, even when definitely

encapsulated, often contains virulent tubercle bacilli in large numbers. Sometimes the number of bacilli present is enormous. Bacilli capable of causing tuberculosis in guinea pigs may be present even when some degree of calcification has occurred, but when calcareous matter forms the principal part of the mass, bacilli are rarely demonstrable. In a given case it is quite impossible to say whether bacilli are present or not in caseous or calcareo-caseous foci (Bugge, '96).

Healing.—The healing of tuberculous processes is always associated with the formation of connective tissue, which may be derived either from the cells in the vicinity of the tuberculous area or from the tuberculous cells themselves, more commonly by far the former. In all cases of chronic tuberculosis there is formed new fibrous tissue, which restrains and limits the spread of the disease, and very often replaces to a greater or less extent the tuberculous formations. Unfortunately such replacement is only too often incomplete, the disease perhaps spreading slowly at the periphery, at the same time as healing and cicatrization take place at the center. As pointed out, caseous material is not at all easily absorbed, and inasmuch as it may contain tubercle bacilli, even when definitely encapsulated and partly calcified, sclerotic districts containing caseous or calcareo-caseous foci can not be regarded as completely healed, but rather as having passed into a state of latency.

Naturally the fibrous tissue that develops in connection with chronic tuberculous processes by its shrinking, often gives rise to contracting scars, deformations, and in the case of tubular organs to strictures. In the lungs, especially, large masses of dense fibrous tissue may develop in the course of healing, and here the coincident occlusion of lymph vessels leads to progressive accumulation of inhaled coal dust within fibrous areas which become black and slaty—slaty induration.

In addition to caseation and calcification, tuberculous tissue may undergo direct transformation into fibrous tissue. Genetically the epithelioid cells in tubercles are fibroblasts derived from connective tissue and endothelial cells, but in may cases these cells are unable to produce mature tissue because they are overtaken by caseation. However, under certain conditions, the bacilli being promptly destroyed or perhaps effectively reduced in virulence, the epithelioid cells in tubercles may proceed in the usual way to form mature connective tissue. This must be regarded as the most ideal mode of healing of tuberculosis. The tubercle now becomes transformed into connective tissue (fibroid tubercle), Cruveilhier's ('62) fibroid metamorphosis. Giant cells may persist in the interior of fibroid tubercles. According to v. Rindfleisch, Klebs, and others (Hektoen, '98), even giant cells may take part in the formation of connective tissue by subdividing into numerous individual, spindle-shaped cells. This fact—namely, that tuberculous giant

cells under certain conditions undergo progressive changes—indicates that they are not merely necrobiotic elements doomed to destruction from their inception, as claimed by Baumgarten and others. On the other hand, it lends support to the view, championed by Metchnikoff, that they are active phagocytes.

POINTS OF ENTRANCE AND PRIMARY LOCALIZATION OF TUBERCLE BACILLI

The determination of the routes of entrance of tuberculosis is of great importance, because of the light thereby thrown on the source and nature of the infection, and the indications thus obtainable as to the best means of prevention. These and allied questions are discussed elsewhere, and at this point suffice it to say that four quite distinct modes of entrance must be recognized, namely: (1) inhalation of bacilli present in dust or minute droplets of sputum; (2) introduction into the digestive tract by means of food contaminated with bacilli and by other means; (3) direct implantation on the skin and exposed mucous surfaces through contact with infectious material; (4) intra-uterine infection through the placental circulation.

The two last methods of infection are regarded as of relatively small importance, and there now exists considerable difference of opinion among investigators with respect to the comparative significance of the first two modes, but the evident tendency is to assign far greater weight than formerly to primary infection by way of the digestive tract, and more especially in children (Harbitz, '05).[1]

The assumption by Baumgarten that tuberculosis in the children of tuberculous mothers, even when originating years after birth, is the result of an intra-uterine invasion, the bacilli remaining latent until the conditions, suitable for pathogenic action arise, is not regarded as susceptible of proof. It is true that Harbitz found animal-virulent bacilli latent in the lymph nodes of children, the nodes being, so far as determined, normal in structure, but the determination of the possible duration of such latency is most difficult, because of the many chances for postnatal invasion.

Whatever the primary point of entrance, the original localization of the bacilli, in the majority of the cases, occurs either at the point of entry or in some group of the regional lymph nodes, most frequently the nearest. It is generally accepted that infection of the lymph nodes

[1] So far as now known, there are no anatomic characteristics that enable one to distinguish between human tuberculosis due to human bacilli and that due to bovine bacilli.

can take place without leaving any recognizable trace at the point of invasion of the tissues. Judging from the frequency of what is regarded as primary localization of tuberculosis, the most suitable organs in the body are the lungs and the lymph nodes. This apparent susceptibility may be due, in large measure, however, to the relatively great frequency with which these organs are exposed to infection, but the localizations in hematogenous infections also point to the affinity of the tubercle bacillus for these organs. The lymph nodes in question are essentially those connected immediately with the digestive tract (tonsils, cervical, mesenteric, retroperitoneal) and with the respiratory tract. According to recent investigations, the lymph nodes are by far the most frequent points of primary tuberculous localization in children (under fifteen). Harbitz, who has studied this question minutely, groups his cases as follows:

Primary in the respiratory tract	41.0 per cent.
Primary in the digestive tract	22.0 "
Primary in the respiratory or digestive tract	20.5 "
General lymph-node tuberculosis, doubtful cases, etc.	16.2 "

In the intestinal cases there may be primary intestinal ulcers. On account of the ease with which tuberculosis may spread in the lymph-vascular system of children, on account of likelihood, in many cases, of hematogenous infection of lymph nodes, and on account of the possibility of simultaneous infection of different nodes, it is not at all an easy matter to make a correct interpretation of many of these cases. As regards the respiratory group of cases, it naturally lies closest at hand to assume an air infection, but descending infection from the cervical nodes and ascending infection from the abdominal nodes frequently cannot be excluded.

It may be suggested that primary tuberculosis of the lymph nodes connected with the digestive tract (cervical and abdominal) does not at all necessarily mean infection with bovine bacilli, because there is often abundant opportunity, especially in children, for contamination of the food and the mouth directly with tuberculous material of human source. It is highly interesting to note that in children tuberculous infection of the lungs probably most commonly results from the rupture of foci in the bronchial nodes into a large bronchus, generally near the hilus, and a consecutive caseous bronchopneumonia often with dissemination to other organs.

Primary tuberculosis of the lymph nodes also undoubtedly occurs in

the adult, and careful post-mortem observations by Lubarsch, Harbitz, and others indicate that in a certain percentage of cases of adult tuberculosis (5.9 Hof, 6.3 Lubarsch, 7.7 Harbitz) the primary localization takes place in the digestive tract, especially the intestine.

Active discussion and investigation is now going on as to the relative frequency of primary and secondary localization of tubercle bacilli in the production of pulmonary tuberculosis, the question having been raised by von Behring, Ribbert, and others whether pulmonary tuberculosis in adults cannot be traced to some remote tuberculous process that existed long before—e. g., in the lymph nodes in childhood. At the present time the general opinion seems to be, however, that while the hematogenous and lymphogenous origin of instances of nonmiliary pulmonary tuberculosis cannot be denied, the disease, in the large majority of the cases, originates from a primary, air-borne infection of the lungs (Schmorl, '01–'02).

The most significant anatomic evidences in favor of the old view are that the oldest lesions generally are found in the lungs, and that in favorable cases it is possible to demonstrate the apparent primary point of invasion—namely, a subepithelial tuberculous infiltration in the wall of a bronchus of medium caliber, or a tuberculous pneumonia or bronchopneumonia with peribronchial tubercle. Birch-Hirschfeld ('99), who made special investigation of this point, found what he considered as the primary lesion most often in the right ramus apicalis posterior. It is evident, however, that even these lesions may result from the deposition in the vessels in the area concerned of bacilli by the blood. Among the reasons assigned for the peculiar predisposition of the apical parts to tuberculous localization are poorer nourishment of these parts, especially at the time of puberty, because the corresponding part of the chest then takes only small part in the respiratory movements. It is also held that at the apex the bronchi branch at such angles that obstruction easily occurs.

DISSEMINATION OF TUBERCULOSIS WITHIN THE INFECTED BODY

In its beginning tuberculosis is always, or practically always, a local disease. So far as known at present the actual primary infection under natural circumstances depends on the entrance and deposition in the tissues of a few bacilli from without. The sources of the bacilli and the various routes of entrance are discussed fully elsewhere. Now, whatever the point of invasion, primary local tuberculosis is likely at any time to become the source of secondary or metastatic tuberculosis. Most commonly the bacilli are carried by the lymph vessels, either free or

within leucocytes. Consequently, lymph nodes draining regions containing tuberculous foci frequently become the seat of secondary tuberculosis from the arrest within them of bacilli brought by the lymph stream.

Progressive local tuberculosis usually is marked by the development of tubercles in the lymph channels in the neighborhood, as shown very well, for instance, in the serous covering over tuberculous intestinal ulcers, about tuberculous foci in the lungs and elsewhere. And from one group of lymph nodes tuberculosis may spread by direct and retrograde transport both upward and downward to neighboring groups, until extensive chains of nodes are involved.

When this occurs in the cervical, thoracic, and abdominal lymph nodes, as happens in children in whom lymphatic invasion appears to occur with great ease, then it may be impossible to form any definite conclusion as to whether the primary infection took place in the respiratory or in the digestive tract. Harbitz considers it likely that in children tuberculosis of the lungs often develops as the result of retrograde transport from the tracheobronchial lymph nodes, because he found tuberculosis in these nodes frequently without involvement of the lungs, but the reverse only rarely. Tuberculosis of the mesenteric, retroperitoneal, thoracic lymph nodes, of the pleura, and of the peritoneum may lead to tuberculosis in the thoracic duct (first described by Astley Cooper, and then by Ponfick), from which bacilli may pass into the general circulation, and thus become distributed in greater or smaller numbers to various parts of the body, with the subsequent development of acute or more chronic generalized tuberculosis. Indeed, tubercle bacilli have been found in the lymph from the thoracic duct in certain cases in which there was no tuberculosis of the duct itself, showing that bacilli were being disseminated from parts drained by the duct.

In connection with the thoracic duct may be mentioned the highly interesting experiments of Ravenel and others, in which indications were obtained that bacilli introduced with the food into the stomach may pass into the thoracic duct and become localized in the lungs, without necessarily leaving any trace in the form of lesions in the intestinal tract or elsewhere that they had taken this route. While there is no evidence that this mode of infection plays an important rôle in human beings, the possibility that tubercle bacilli may become localized at points more or less remote from the point of penetration into the tissues, and thus set up lesions that may become the center for other more or less remote foci, indicates the great difficulties that may be encountered in the efforts to determine the route of entrance by anatomic methods of investigation.

Tubercle bacilli may reach the blood also as the result of direct

tuberculous invasion of the walls of blood-vessels and the discharge of bacilli directly into the blood stream (see Miliary Tuberculosis).

Dissemination of bacilli within the infected body takes place also by way of mucous and serous membranes. The routes of secretion and excretion are important means for the spread of tubercle bacilli to the outside of the body as well. Thus, the discharge of a disintegrating tuberculous focus in the lung or of peribronchial lymph nodes into the bronchi may result in the conveyance of bacilli not only to the outside of the body, but also to various parts of the respiratory tract, as well as, by swallowing the sputum, to the digestive tract, where secondary localizations in the intestinal lymph follicles often occur. In this way instances of primary infection of the peribronchial nodes, for example, may give rise to acute tuberculous bronchopneumonia. In the case of the urinary tract, the breaking down of tuberculous masses in the kidney may cause widespread infection of the pelvis, ureter, and bladder.

Finally, the entrance of bacilli into a serous cavity from some focus adjacent is often the cause of diffuse and acute tuberculous inflammation. In the case of the pleura and the pericardium, general tuberculosis may arise either from tuberculous pulmonary foci or from foci in the thoracic lymph nodes. Peritoneal tuberculosis often takes its origin in caseous lymph nodes, tuberculous intestines, and, in the female, in tuberculosis of the genital organs. In all these cases the bacilli are distributed by movements on the part of the walls and the contents of the cavities in question. In the leptomeninx the bacilli also spread rapidly.

Inasmuch as the bacillus of tuberculosis does not possess the rapid power of growth in the body that characterizes the microbes of the typical acute infectious diseases, the acute manifestations of tuberculosis—acute miliary tuberculosis, acute tuberculous pneumonia, and acute tuberculosis of serous membranes—all result from the more or less sudden or rapid dissemination of masses of bacilli that have accumulated in some preëxisting focus. So far as we know, that is the only way in which acute human tuberculosis arises under natural conditions.

ACUTE GENERAL MILIARY TUBERCULOSIS

Acute miliary tuberculosis, in which innumerable tubercles develop in various parts of the body at about the same time, is now universally held to result from the introduction into the circulation of large numbers of tubercle bacilli, either at one time or at frequent intervals. It is regarded as a secondary infectious disease. A primary form is not recognized. It is most frequently observed in connection with pulmonary and lymph-node tuberculosis, but it may occur secondarily to

tuberculosis of bones and joints, of the pleura, pericardium or peritoneum, of the adrenal, urogenital organs, etc.

The modern conception of the nature and genesis of general miliary tuberculosis takes its origin in the remarkable statement by Buhl ('72) that miliary tuberculosis is an infectious and resorption disease, the miliary nodules having the same relation to the caseous foci as the metastatic abscesses in pyemia have to the primary focus of suppuration.

It was reserved for Carl Weigert to furnish the actual demonstration of the manner in which tuberculous material may enter the blood, namely, by the tuberculous invasion of the walls of blood-vessels or of the thoracic duct. Older pathologists regarded the blood-vessels as immune to tuberculosis, and Weigert's observations put an end to this theory. He first described the extension of a caseous tuberculosis in a lymph node through the walls of the vena anonyma ('78), and shortly afterwards tuberculous invasion of the pulmonary veins.

Shortly before the discovery of the tubercle bacillus, Weigert ('82), who in the meantime had found tuberculous foci in the veins in ten and in the thoracic duct in two of three cases of acute general miliary tuberculosis, announced that a tuberculous lesion of a vein or other vessel must fulfill the following conditions before it can be regarded as the source from which the miliary tuberculosis has sprung:

1. The primary lesion must, by its appearance and structure (caseation, size, etc.), prove to be of greater age than the miliary nodules.

2. The tuberculous focus must occupy a portion of the wall of a vein or larger lymph channel which is patulous.

3. The eruption of miliary tubercles must be of such a character as to be only explainable by the theory that a large amount of tuberculous poison has entered the blood at once, and that, in other words, their development has occurred in a relatively short space of time.

4. The tuberculous poison must actually extend to the surface of the focus; that is, it must communicate with the lumen of the vessel. In the ductus thoracicus, where the nodules are placed on the free surface of the vessel lumen, this is usually the case. In the compact foci of the veins—for instance, the pulmonary veins—at least a portion of the focus must be softened or caseated.

5. The venous tubercle must not be located in the portal system, otherwise the tuberculous poison would all be deposited in the liver.

With the possible exception of the fifth condition, we are not able to say that under the circumstances in question the portal capillaries will hold back all tubercle bacilli, and on substitution for tuberculous poison of tubercle bacilli, Weigert's conditions hold good to-day. Koch first demonstrated bacilli in tuberculous lesions of veins and of the thoracic duct, and soon Weigert was able to show their presence in his

own specimens. Weigert's masterly grasp of the problems and his brilliant interpretation of his observations will always excite the highest admiration of students of tuberculosis. All subsequent investigations uphold his teachings in the main points. The attempt by Wild ('97) to show that general miliary tuberculosis is the result, at least in part, of the multiplication of the bacilli in the circulating blood, which they enter by more or less undiscoverable sources, has not received any general support.

Tuberculosis of the walls of blood-vessels may develop in different ways. Direct extension may take place from adjacent tuberculous foci or the process may be started by single or multiple metastasis on the vascular intima or in the wall itself, and rarely on the endocardium. Several instances of intimal aortic tuberculosis have been described as due to the implantation of tubercle bacilli (Blumer, '99), and Benda considers this the more frequent mode of origin of the vascular tuberculosis that leads to general dissemination, but that view is not generally accepted, at least not with respect to the blood-vessels. The extension of tuberculosis from the neighborhood may involve arteries and veins, but the veins more frequently. The aorta has been found extensively involved in this manner also. Of blood-vessels, the pulmonary veins most often furnish the starting point for miliary tuberculosis, but the jugular vein, the suprarenal, the vena cava, the dural sinuses, the vesical veins, the endocardium, the aorta, and the pulmonary artery —all may play this rôle.

Recent investigations indicate that tuberculosis of the thoracic duct possibly is the most frequent cause of general miliary tuberculosis. Thus Benda ('99), in 19 cases found the point of origin to be the thoracic duct in 12, and Longcope ('06) in 19 typical instances of generalized acute miliary tuberculosis found in 14 cases more or less extensive tuberculosis in the thoracic duct, usually with caseous nodules. In all of these cases Longcope noted that the mesenteric, retroperitoneal, or thoracic lymph nodes were the seat of chronic tuberculosis.

In order to study the duct satisfactorily, it must be dissected free from its beginning in the receptaculum chyli to its entrance into the left subclavian vein. Solitary tubercles may occur in its extreme upper part. It is often difficult to determine the starting point of the acute generalization of tuberculosis, but in the hands of experts success has been achieved in as high as ninety-five and even one hundred per cent.

Naturally it may be difficult to determine that a given focus of tuberculous vasculitis really is the point of origin, as there may be more than one such focus in the same body. In case the lumen is not closed by proliferation and thrombosis, it is easy to understand how a tuberculous process in a vascular wall, on caseation and disintegration, may

give off tuberculous material and bacilli into the blood or lymph, especially since it has been found that tuberculous masses projecting into the lumen commonly contain enormous numbers of bacilli, often in heaps, in the parts near the current. Indeed, it seems as if those parts which sometimes are rough and irregular, and sometimes smooth from fibrinous deposits, present especially favorable conditions for the multiplication of the bacilli. Generally the vascular tuberculous masses—"vascular tubercle"—appear as grayish yellow nodular elevations, and at times they may be distinctly polypoid; when the result of extension or erosion from without they are connected with an extravascular tuberculous area.

The localization as well as the number of tubercles in miliary tuberculosis are subject to considerable variation, depending on the exact location and nature of the point of invasion and on the number of bacilli sent into the circulation. If the primary focus is situated in the walls of a smaller artery, then the consecutive eruption of miliary tubercles may be confined largely to the corresponding capillary district, and we speak of a local hematogenous miliary tuberculosis. Often the position of the original vascular focus may be surmised from the distribution of the tubercles; this is true especially of the lungs in chronic pulmonary tuberculosis (partial disseminated hematogenous miliary tuberculosis). But even under these circumstances, bacilli may pass through the nearest capillary filter and give rise to scattered tubercles in different organs and tissues, which is not infrequent. In the chronic generalized tuberculosis peculiar to children, numerous widely spread, large caseous foci are found, due to dissemination of few bacilli by blood as well as lymph vessels. Naturally there are all grades of transition between these various forms.

In typical, generalized, acute miliary tuberculosis most of the organs are permeated by uncountable tubercles, but by no means to the same degree. Certain organs, by means of mechanisms that are not understood as yet, appear to resist the development in them of miliary tubercles, notably the pancreas, the salivary glands, and the skeletal muscles. Of all the organs the lungs, the liver, the spleen, the kidneys, and the serous membranes are most commonly and most extensively involved in general miliary tuberculosis. The occurrence of chorioidal tubercles is of much clinical interest. It is noteworthy that the tubercles occur most numerously in the vicinity of the blood-vessels, and intimal miliary tubercles are not uncommon, especially in the lungs and leptomeninx.

The tubercles, while at first glance of about the same grade of development, as a rule will be found to vary in size from minute grayish transparent points that are barely visible to larger nodules with grayish-yellow or yellowish-white centers. And on microscopic examination

numerous young tubercles will be found that clearly could not be recognized by the naked eye. On serous surfaces—e. g., the pleura—in the lungs, and on the surface of the kidney, they are usually surrounded by an areola of congested vessels. In the serous cavities there may be more or less exudate present when miliary tubercles develop on the lining.

The spleen is enlarged; young tubercles are confounded easily with the Malpighian bodies; the tubercles, however, are somewhat more projecting and easily peeled out with the knife point; caseating tubercles are easily distinguished.

The liver also is somewhat enlarged, and tubercles can be recognized in the interlobular connective tissue as well as in the interior of the lobules.

In the kidneys miliary tubercles are found, particularly in the cortical parts and often in rows. Occasionally they are confined to the vicinity of a single branch of the renal artery. Tubercles on the surface of the kidney may form small prominences surrounded by injected vessels.

In the peritoneum miliary tubercles occur frequently, and especially in the omentum, which may be rolled up and retracted. There may be peritonitis.

In addition, tubercles occur in the genital organs, lymph nodes, adrenals, tonsils, the thyroid, the heart (pericardium, myocardium, endocardium, especially of the right ventricle), the bone marrow, and rarely in the stomach and in the skin. In the meninges, especially the leptomeninx, miliary tuberculosis gives rise to characteristic changes.

Tuberculosis of the pia-arachnoid occurs by preference at the base of the brain and over the cervical spinal cord. Sometimes there is only slight turbidity of the membranes, but usually there is fibrinopurulent or gelatiniform fibrinous exudate most marked about the Sylvian fissures, the optic chiasm and interpeduncular spaces. There is acute hydrocephalus. Miliary granulations are seen especially about and on the middle cerebral arteries and the arteries of the anterior and posterior perforated spaces. The tubercles may be hard to see, and it is best to spread the membranes on a glass plate. Large or caseous nodules are often present and the inflammation extends into the brain tissue (meningo-encephalitis). In tuberculous meningitis there is an interesting endarteritis with tubercles and diffused subendothelial proliferation, best explained as due to implantation of tubercle bacilli and their products from the blood. The infiltration often spreads into the other coats, all of which may undergo caseous and hyaline degeneration. Tuberculous arterial and venous changes also are common as the result of extension from without.

THE MORBID ANATOMY OF PULMONARY TUBERCULOSIS

In the lungs tuberculosis produces a complex variety of anatomic alterations, depending, on the one hand, on the mode of invasion, and on the other on the number and the relative virulence of the infecting bacilli, as well as on the kind of resistance offered by the infected body.

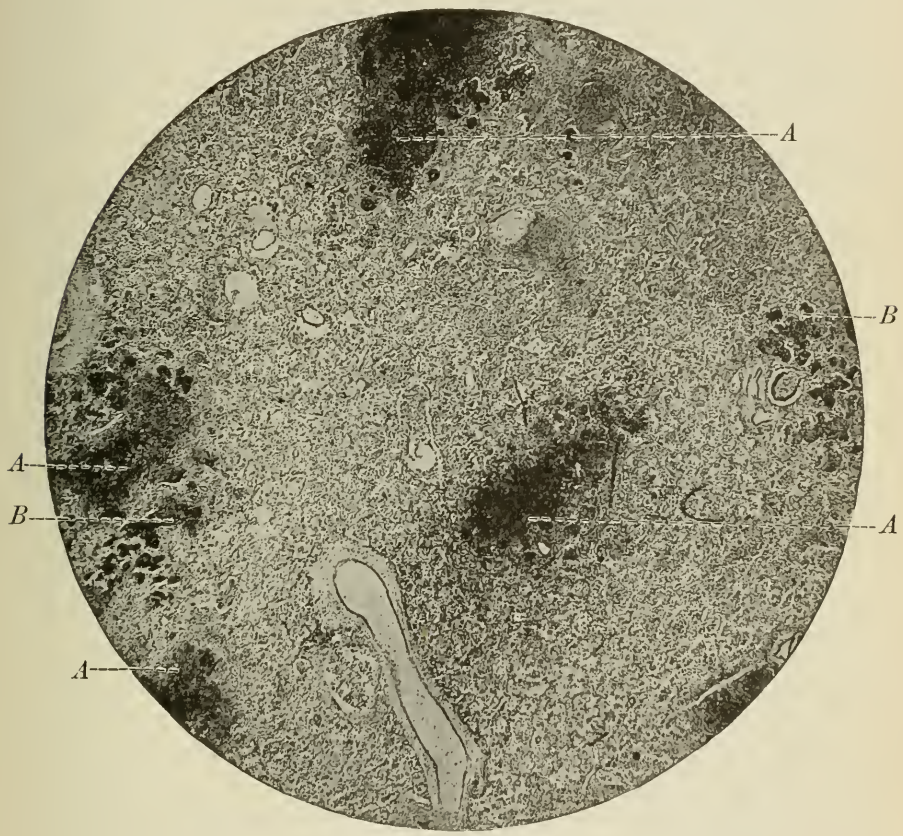

FIG. 6.—TUBERCULOUS PNEUMONIA AND CONGLOMERATE TUBERCLES. (*A*) Spots of tuberculous pneumonia. (*B*) Single tuberculous air vesicles and groups. Early stage of process. (From Holt "Diseases of Infancy and Childhood," 1908.)

The anatomic pictures presented by pulmonary tuberculosis consist of miliary and larger nodules, pneumonic and bronchopneumonic areas, with, on the one side, caseous softening with ulceration and cavity formation, and on the other the production of fibrous tissue, cicatrization and limitation. (Fig. 6.)

According to the accepted modes of entrance of tubercle bacilli into

the lungs, it is customary to speak of hematogenous, lymphogenous, and aërogenous pulmonary tuberculosis. When acute and typical there is no difficulty in the recognition from anatomic appearances of the first two; all three modes of invasion may lead to the common manifestations of tuberculosis of the lungs in the clinical sense, and in well-established cases it may be difficult to determine from the anatomic lesions the exact route of entrance into the lung.

Acute General Hematogenous Tuberculosis of the Lungs.—The nature and origin of general miliary tuberculosis have been discussed. It remains to describe the most striking appearances of the lungs in this disease which may appear in previously healthy lungs or in lungs the seat of existing tuberculosis. In either event, tubercles are found in the majority of the other organs of the body.

The lungs on palpation are finely nodular or granular throughout, of increased weight and consistence, usually somewhat distended. They do not collapse on section. The tissue is red from congestion, frequently somewhat edematous, and everywhere permeated with tuberculous nodules which, in many cases, gradually diminish in size from the apices downward. These nodules are not all miliary tubercles in the accepted sense; many are conglomerations, and Orth especially has emphasized that in miliary tuberculosis of the lungs there spring up about the proliferative nodules, as well as elsewhere, pneumonic and bronchopneumonic—i. e., exudative, rapidly caseating areas that on gross examination may appear as somewhat projecting round or angular nodules. This form of inflammatory reaction shows that the bacilli and products may act directly on the alveolar wall and reach the lumen even when the infection arrives by way of the blood. The proliferative tubercles occur mostly in the adventitia of the vessels of the septa, in the perivascular and in the peribronchial tissue. Tuberculous endarteritis is not infrequent.

Often there are areas of moderate emphysema in the lungs of miliary tuberculosis. The reasons that the lesions in the upper parts are farther advanced than in the lower are not altogether clearly understood. It is thought that the upper parts are more vulnerable, because they contain less blood than the lower parts, and that the bacilli that escape into the alveoli are more easily removed as we approach the base.

Under certain conditions the hematogenous foci may be found so much enlarged and caseous that the condition is designated as subacute or chronic.

Pulmonary miliary tuberculosis is nearly always associated with typical tubercles on the pleura, which also may show more or less fibrinous or sero-fibrinous exudate.

Partial Disseminated Hematogenous Tuberculosis of the Lungs.—This form, which is not common, arises when bacilli are distributed

by the blood over a limited part of the lungs. It usually arises in the course of existing tuberculosis in the lungs from tuberculous erosion of, or the breaking down of, intimal tubercles upon some branch of the pulmonary artery. One reason for its infrequence is the fibrous narrowing and occlusion of many vessels in chronic pulmonary foci. Naturally, single foci can arise from the lodgment in the lungs of few bacilli brought in the blood from tuberculous areas elsewhere, and such metastatic foci may become the starting point of chronic pulmonary tuberculosis.

Localized Pulmonary Tuberculosis.—The minute early steps in the evolution of local pulmonary tuberculosis may be traced somewhat as follows: Assuming the bacilli to be inhaled, lodgment may take place either on the wall of a small bronchus or in the alveoli (in either case usually near the apex). In the first instance a bronchial tubercle may result, followed by gradual extension and caseation, until the wall is converted into a partial or complete caseous ring. Caseous matter and mucus will accumulate in the lumen, and in consequence the corresponding alveoli may collapse, and if not rendered tuberculous, induration can result.

From the bronchial focus the process can extend outward into the peribronchial tissue and adjacent alveoli, where desquamated epithelial cells and lymphocytes accumulate at the same time as fibrin is precipitated; in brief, a pneumonic or bronchopneumonic area develops in which caseation soon takes place. In the meantime the blood-vessels in the alveolar walls become hyaline, and often the large vessels are plugged by fibrin, hence the area becomes bloodless and yellowish-white in color.

Radicals of the peribronchial lymphatics being included in the tuberculous district, the bacilli easily find their way into the lymph vessels, and peribronchial tuberculous lymphangitis results, the tubercles sometimes running around the bronchi like a string of beads, and now extension may take place to the bronchial walls or to adjacent alveoli. Occasionally the process can be followed as peribronchial nodular cords clear to the lymph nodes at the hilus.

If the bacilli enter the alveoli directly, then a minute pneumonic focus may result, or the bacilli may be carried by wandering cells into the interstitial tissue, there to form tubercles. In either case the exact mode of genesis would soon be obliterated because the interstitial tubercles would soon lead to pneumonic changes, and a primary pneumonic lesion would soon be followed by interstitial processes.

As a rule, tubercles with giant cells are the more numerous the slower the process, while in rapidly spreading pneumonic exudation, with early caseation, tubercles and giant cells may be few and even absent.

Early stages of primary localization in the mode here outlined are not often seen at autopsies. Occasionally, however, one finds that a small area, usually near the apex, may show grayish or yellowish granules and areas either in groups or more scattered.

The further fate of such primary foci varies. Healing by connective-tissue replacement, or encapsulation, with calcification, is not uncommon; but frequently the opposite occurs—namely, softening and extension. If the process involves a bronchus or bronchiole, either primarily or by extension, then the caseation may weaken the walls so that it dilates and the so-called bronchiectatic cavity results. Cavities arising from softening in closed caseous pneumonic areas usually empty themselves into a bronchus.

Early in the process caseous disintegration of the wall of a bronchus may cause rupture of small blood-vessels, and thus give rise to the spitting of blood that occurs so often in the first stages of pulmonary tuberculosis.

In the further progress of local pulmonary tuberculosis there arise various more or less distinct anatomic forms, which correspond fairly well to recognizable clinical manifestations of the disease, according as certain processes outlined in the foregoing predominate.

Tuberculous Pneumonia.—Characteristic exudative pneumonic changes may develop at any time in the course of pulmonary tuberculosis as the result of entrance into the alveoli of bacilli or their products, in sufficient quantities to cause exudation and immigration. Tuberculous pneumonia differs from all other forms of pneumonia in that the end is caseation. This pneumonia may vary greatly in its extent and course so that lobular or bronchopneumonic and lobar, as well as acute and subacute and chronic forms, are recognized.

Tuberculous bronchopneumonia is the more common. It develops oftenest in the lower lobes as the result of aspiration of tuberculous material from cavities and older lesions into the bronchi and alveoli, and there is usually a smaller or larger number of areas of more or less simultaneous development. This form of pulmonary tuberculosis occurs most frequently in children (after measles, whooping cough, etc.) and young persons, in whom it commonly assumes a rapid progress. In such cases the peribronchial lymph nodes are usually large and caseous, and frequently the invasion of the lungs follows rupture of a tuberculous node into a large bronchus near the hilus (Fig. 7). When associated with softening and the production of cavities, in which secondary infection may take part, it constitutes the acute phthisis or galloping consumption of the clinician.

In the earlier stages the bronchopneumonic foci are grayish-red; as caseation takes place they become yellowish or whitish, opaque, dry and

prominent, granular on the cut surface. They vary much in extent; by fusion of contiguous areas larger districts and groups arise, between which lies crepitant lung tissue or a zone of grayish-red, gelatinous, sero-fibrinous infiltration (gelatinous pneumonia), in which proliferation and desquamation are comparatively slight. Such infiltrations occur particularly about caseous districts that are rich in bacilli and are regarded, at least in many cases, to result from the action of the products of the bacilli. Extensive lesions occur without the eruption of tubercles, but there may be varying combinations with proliferative tuberculous and fibrous changes.

In more chronic forms the proliferative changes are more marked and bacilli then are found principally at the periphery of the caseous masses and sometimes in large heaps. As caseation extends the capillaries become hyaline, there is more or less obliterating endovasculitis, and eventually only coal dust and remnants of elastic tissue remain to indicate the former location of the alveolar and bronchial walls. In case the process becomes stationary, fibrous tissue may form at the periphery, and in time an encapsulated fibro-caseous or calcareo-caseous mass may result.

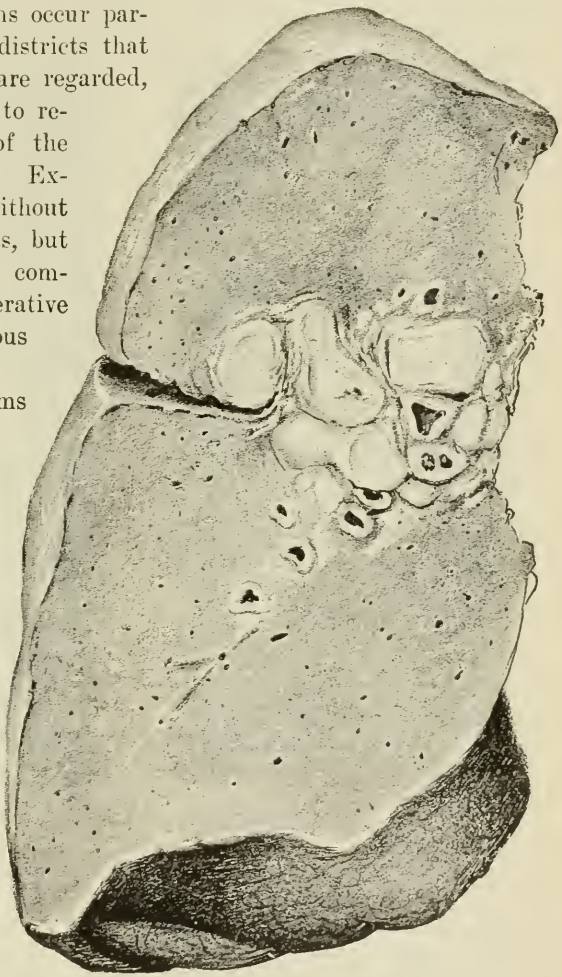

Fig. 7.—Section Through Lung, Showing Caseous Tuberculous Lymph Glands. Lung normal. (From Northrup.)

Tuberculous lobar pneumonia is much less common. It may result from the coalescence of numerous bronchopneumonic areas (pseudo-

lobar) or from simultaneous involvement of a whole lobe or even an entire lung in which there is then an older focus, usually a cavity near the apex, from which inundation of the tissue with tuberculous products, formed and in solution, has taken place. The affected parts are heavy and airless and the pleura usually covered with exudate. Distinct tubercles or groups of tubercles may be recognized in places on the

FIG. 8.—TUBERCULOUS PNEUMONIA IN A CHILD THIRTEEN MONTHS OLD. Vertical section through right lung. Upper lobe caseous (diffuse tuberculous pneumonia). Beginning excavation near center. Below simple pneumonic consolidation. Lower lobe appears normal. (From Holt, "Diseases of Infancy and Childhood," 1908.)

FIG. 9.—CAVITY FROM BREAKING DOWN OF TUBERCULOUS PNEUMONIA. Same lung as in Fig. 8. Normal lower lobe shown. (From Holt.)

cut surface, which is grayish, grayish-yellow, or, in the older parts, peculiarly yellowish-white and caseous. Sometimes a lobe and even an entire lung is caseous, with more or less extensive softening and cavity formation.

Ulcerative Tuberculosis of the Lungs.—This group includes especially the forms in which softening and ulceration are prominent features. The lungs present a variety of lesions, including tuberculous nodules,

pneumonic districts, caseous masses, cavities of various sizes and ages, and fibrous changes. The oldest lesions usually are at the apices, the disease having progressed downward, commonly more rapidly in one lung than the other.

In addition to aspiration the lymph vessels take an important part in the spread of chronic pulmonary tuberculosis (peribronchial and perivascular extension). In some cases, notably in children, the miliary and larger nodules are distributed about the older foci in a radial manner. At other times the dissemination is more scattered. From peribronchial tubercles may arise caseous, fibrocaseous, and fibrous masses or by extension areas of bronchopneumonia. While the primary focus of lymphogenous invasion commonly is situated in the lungs themselves, it may be found also in parts directly connected with the lungs, either normally or as the result of inflammatory processes, such as lymph nodes, ribs, sternum, spine.

Typical bronchopneumonic areas develop in ulcerative tuberculosis due to aspiration of the tuberculous matter from the older lesions into the lower parts of the lungs. Such areas may soften or become transformed into encapsulated caseous, calcareo-caseous, or calcareous masses. Smaller tuberculous areas, whatever their mode of origin, may be found surrounded by grayish-red zones of pneumonic exudation. Tuberculous ulcerations may be found in the mucous membrane of the larger bronchi. *Bronchiectasis* is often present.

The cavities are a distinguishing feature of this form of pulmonary tuberculosis. They arise because physical and chemical changes lead to the softening of the caseous substance into a thick suspension not unlike pus. More frequently this begins in the wall of a diseased bronchus which becomes more or less dilated. The detritus contains fragments of dead cells, elastic fibers, and usually numerous bacilli. Smaller cavities by extension may coalesce, and in a short time large excavations result in acute cases. Breaking down may occur also in the center of a closed caseous area; in this case communication with a bronchus becomes established later.

The size and form of a cavity depend originally on those of the focus in which it originates. If in a caseous peribronchial nodule or in a small bronchopneumonic area, then the cavity, at least at first, is small, circumscribed. In large areas of caseous pneumonia, spots of softening may coalesce, and there may form irregular caverns without definite walls. In acute progressive cases one or more lobes may be more or less excavated in a short time. In the chronic ulcerative tuberculosis there are older cavities with definite walls in the upper lobes, while lower down may be more recent ones without any definite limiting membrane. In older cavities a more or less distinct wall or mem-

brane is present from which pus is discharged; by necrosis, and by caseation of tuberculous foci in the adjacent tissue, gradual extension is effected. Extremely large cavities may result. On the inner surface

Fig. 10.—Tuberculosis of Eleven Years' Standing. Resident of Colorado one month. Right lung shows cavity the size of a small orange at apex with extensive consolidation. (Dr. J. A. Wilder's case, Denver.)

of older cavities are bands and irregular projections, the remnants of the framework in which traces of bronchi and vessels may be recognized. (Fig. 10.)

Occasionally minute aneurysms (1 to 3 mm.) form on the exposed branches, rupture of which is one cause of the hemorrhage of ulcerative tuberculosis. More frequently the larger hemorrhages result from erosion by caseation of suppuration. Decomposition of the contents of cavities may be followed by gangrene. In quiescent cavities the wall is cicatricial and the inner surface has a smooth lining. The neighborhood is then usually fibrous, and shrinking may have occurred to the extent that smaller cavities are obliterated or reduced to fistulous passages. At the apex pleural adhesions usually prevent obliteration of large cavities.

The pleura is usually fibrous over old cavities and firm adhesions are the rule, especially about the apices, and thus rupture of cavities into the pleura is prevented. Sometimes the fibrous pleura contains tuberculous nodules, and exudative pleuritis is not infrequent. Rarely cavities rupture externally at the point of pleural adhesions; fresh, usually small, cavities in the upper lobes or suppurating cavities, situ-

ated closely to the pleura, may rupture into the pleural sac. The opening may be very minute. The usual immediate consequence is entrance of air into the chest cavity, on which follows, as a rule, suppuration (pyopneumothorax). The peribronchial lymph nodes are usually tuberculous; in chronic, stationary, or healed cases often calcified.

Tuberculous changes are frequent in other regions, and first of all in the larynx and intestines, in which they result from surface infection by bacilli from the lungs. The pericardium may be involved by extension. Acute and chronic hematogenous tubercles may be found in the spleen, kidneys, brain, liver. The spleen, liver, kidneys, and intestinal mucus are often the seat of amyloid changes, and the liver is frequently fatty.

MIXED INFECTION IN PULMONARY TUBERCULOSIS

The variety of lesions in ordinary pulmonary tuberculosis long ago suggested the question whether in reality several simultaneous or superimposed diseases were not concerned. While Laennec favored strongly the view that all the lesions were tuberculous, Virchow held that the tubercle and the caseous pneumonic foci were different processes etiologically. This question of the unity or duality of the chronic pulmonary tuberculous (phthisical) process was settled finally in favor of Laennec's view, when it became possible, as a result of the discovery of the tubercle bacillus, to demonstrate the etiologic unity of tubercle and of caseous pneumonia. While the studies of Orth ('07), Fränkel and Troje ('94), and others leave no doubt as to the correctness of this conclusion, the part played by secondary infection in pulmonary tuberculosis merits consideration.

The actual investigations (Sata, '99; Ophüls, '00), as to the conditions in the lungs in more or less advanced pneumonic and ulcerative tuberculosis, have shown that secondary mixed infection is a frequent event. Thus in Sata's 21 cases actual mixed infection—that is, invasion by bacteria of the walls of cavities or the interior of bronchopneumonic foci, either alone or in conjunction with tubercle bacilli—was established in 12 (streptococci predominated in 6, pneumococci in 4, staphylococci in 1; among other bacteria were colon and pseudodiphtheria bacilli). Of 26 cavities examined by Ophüls, 7 contained the tubercle bacillus only; in the others were mixtures of bacteria (the streptococcus, pneumococcus, and pseudodiphtheria bacillus predominating).

Undoubtedly mixed infection may occur from the beginning; it may cause areas of bronchopneumonia and promote disintegration of caseous material and the formation of cavities. Prudden ('94) showed that in rabbits with caseous pneumonic areas, intratracheal injections

of streptococci were followed by rapid softening and formation of cavities. Or the infection may take place after softening in purely tuberculous areas and open a communication with the bronchi. Naturally such foci constitute favorable soil for bacteria other than tubercle bacilli; vegetating here, their products, on absorption, producing toxic effects; they also may enter the walls of the cavities or be carried with other contents to other parts of the lungs, in either case setting up foci of inflammation with more or less constitutional disturbances.

It lies close at hand to assume that invasion of the blood often takes place from the foci of mixed infection in the lungs, but on account of other possibilities no final conclusions may be drawn. In 50 cases in which Teissier ('01) examined the blood bacteriologically during periods of hectic fever, streptococci or staphylococci were recovered in 9.

FIBROID, QUIESCENT, AND HEALED TUBERCULOSIS OF THE LUNGS

Limiting and indurative processes are encountered in various stages and forms in pulmonary tuberculosis. Frequently the earliest foci in the apices show extensive fibrous change, and scattered bronchopneumonic as well as peribronchial foci may undergo fibrous transformation and heal, with or without calcification. Occasionally in the case of somewhat larger foci the central part becomes fibrous and hard, while small caseating nodules are scattered about at the periphery, the whole resembling somewhat a rosette with sunken center.

When the fibrous process is extensive the condition usually corresponds to the so-called fibroid tuberculosis (tuberculo-fibroid phthisis), which may supervene on either the ulcerative or the more definite bronchopneumonic form of tuberculosis. In either case there is usually a cavity or a series of cavities in one apex, surrounded by dense fibrous tissue, with more or less extensive induration of the surrounding districts. The corresponding pleural cavity is largely or completely obliterated by firm adhesions, bands passing inward into the various parts of the lung, in which there is more or less extensive and diffuse or more nodular (bronchopneumonic) fibrous changes, with here and there scattered caseous areas. Usually there is some active tuberculosis somewhere in the lungs. The scar tissue in the lungs may compress the bronchi so that areas of alveoli collapse, to be followed by a persistent edema or by progressive induration. The unaffected parts of the lung tissue may be emphysematous.

A tuberculous process may be regarded as healed only when there has formed a more or less structureless connective tissue with or without calcareous deposits but without caseous material. Caseous foci, though

evidently old, partly calcified, and encapsulated, may contain animal virulent bacilli (Bugge). Quiescent or healed tuberculous areas are found most commonly in the apices. There may be nodular encapsulated masses containing caseous or more puttylike material, often calcareous, over which the pleura is retracted or corresponding to which there is adhesion. Microscopically the process may be clearly at a standstill, the capsule being composed of fibrillary or hyaline tissue and fibrous tubercles may be scattered about. Occasional fresh tubercles are seen.

Anatomically areas of healed tuberculosis oftenest appear as slaty indurations, usually apical and subpleural, flat or nodular, with retraction or adhesion of the pleura, and inclosing small calcareous masses, fibroid tubercles perhaps being present in the adjacent tissue. Mere slaty indurations are not sure signs of healed tuberculosis, as they may arise from inhaled dust, in the healing of infarcts, and after nontuberculous pneumonia. Bugge found that of 138 persons over one year of age who died from other causes than tuberculosis in the lungs, thirty-five per cent presented changes that could be interpreted as due to healed tuberculosis.

At the International Congress in Washington (1908) Bartel emphasized that because invasion of lymph nodes by tubercle bacilli may give rise to a lymphocytic hyperplasia and in some cases lead to no apparent changes whatsoever, it often becomes a matter of great difficulty to determine the exact point of entry of the bacilli into the body. In other words, manifest typical tuberculosis is not a sufficient basis for the determination of the point of entrance. Bartel holds that infection from the pharynx, stomach, and intestines, especially early in life, is more frequent than generally believed. From post-mortem observations Wollstein concludes that in infants and in young children the instances of tuberculosis of respiratory origin are more numerous than those of digestive origin.

CHAPTER III

RESISTANCE, PREDISPOSITION, AND IMMUNITY

By EDWARD R. BALDWIN

RESISTANCE

Animals in General.—So far as is known, no animal is absolutely immune against tuberculosis, but wide differences obtain in the susceptibility of different species. The herbivora are, as a rule, the least resisting, the carnivora the most, while the omnivorous varieties are probably intermediate in this respect. Guinea pigs, rabbits, and cattle evince great susceptibility to bovine tuberculosis, while dogs, cats, foxes, lions, tigers, etc., require larger doses or special conditions to produce infection. On the other hand, asses, goats, horses, rats, mice, and other rodents are highly resistant, while swine, apes, and monkeys are very susceptible to both human and bovine tuberculosis. Nearly all birds are insusceptible to mammalian tuberculosis, but are very easily infected with the avian type, though the carnivora here also have more resistance.

Man.—Mankind forms no exception among the animals by having a notably greater degree of resistance than other omnivora, yet he is less easily infected than the small herbivora, and quite resistant in healthy adult life. A greater difference would appear to exist between individuals of the human race in their natural resistance than between the lower animals of the same kind.

It has been an important question to settle as to the susceptibility of man for the bovine type of bacillus, and the matter may now be considered determined that there is no reason to think that mankind is less susceptible to it than to the human type. It is also held to be possible that the avian bacillus may occasionally infect human beings (Pansini, '94; Rabinowitsch, '04).

Individual Resistance.—The resistance possessed by each individual is the chief object for study in order to arrive at a correct understanding of the nature of man's defenses against this disease. It is evident that such defenses may be considered normal when applied to a person in perfect health and of good physique, or subnormal if descriptive of one who is structurally and functionally "predisposed" to tuberculosis, in the broad meaning of the term. Still further, one may conceive of an

increased resistance, either natural or acquired, and finally the existence of an actual immunity. In a problem of such inherent complexity it is not to be supposed that all the factors constituting resistance to disease will be considered here, but only those especially applicable to tuberculosis. It is, nevertheless, true that no other disease illustrates so fully the import of those principles of physiology that have to do with the protection of life from parasitic enemies.

NORMAL PHYSIOLOGIC RESISTANCE

All clinical experience bears witness to the fact that adults of good physique, in functional and organic health, possess a nearly perfect protection against natural infection by tubercle bacilli.

There is, first, the external skin, which is rarely inoculated with serious results; then the mucous membranes, which are amply protected by ciliated epithelia, and the mucous secretions, which, when in healthy condition, act mechanically in removing inhaled or swallowed bacilli. The reflexes, coughing and sneezing, the normal digestive and vaginal secretions also act mechanically or chemically as protective agencies. To these may be added intestinal peristalsis and the cleansing effect of the outward flow of the tears and urine. While it is very doubtful if any of the secretions mentioned act strongly bactericidal to the tubercle bacillus under natural conditions, the gastric juice and vaginal mucus probably weaken it. It is also questionable whether the epithelia of the lung alveoli are normally invulnerable by the tubercle bacillus.

Influence of Age.—The influence of age is important in connection with resistance to tuberculous infection. Infants and young children are normally very susceptible, often in spite of apparent buoyant health. The frequency of tuberculous meningitis among the best-developed and healthy infants is testimony to this fact. Moreover, the delicate epithelial covering and easily permeable lymph spaces present but a slight barrier to infection during early childhood, and at birth the incomplete development of the gastro-intestinal mucosa is made responsible by von Behring ('03) for much infantile infection by means of food. With growth the resistance increases and attains its maximum between twenty-five and fifty, after which, doubtless, a second period of relative susceptibility ensues, though clinically less easily discernible.

Influence of Heredity.—The value of a good vigorous ancestry has always been recognized in connection with the warding off of consumption, but a belief in its infallible protection has too often led to serious errors and procrastination among patients. In the ante-bacillus era the influence of heredity in the direct causation of consumption was considered paramount and naturally overestimated. The inheritance of functional characteristics which are attributes of good health is quite

as obvious as the opposite, and is of great importance to normal resistance. Racial differences are also to be noted (*vide infra*).

Nature of Physiologic Resistance.—Much study and speculation have been expended on the processes of cellular resistance in relation to tuberculosis. No attempt to correctly interpret nature's methods has yet been wholly successful, but we may assume that they do not vary in essential features from those employed to combat other bacterial infections. The condition of the blood in possessing a normal content of salts, normal alkalinity, and absence of an excess or deficiency of certain ingredients, are doubtless factors of importance. Normal coagulability, agglutinating, opsonifying, and bacteriolytic functions attaching to the plasma are presumably of especial importance in the localization and destruction of tubercle bacilli, judging from their lessened power in the blood of persons who lack resistance. On the other hand, no one element has proved a safe criterion of resistance thus far, although it is possible that the determination of the opsonic index, as introduced by Wright and Douglas ('04), of London, may eventually become a measure of resistance values.

In the last analysis all the phenomena of resistance depend on the reactions of the living cells of the body, and here we meet great difficulty in observing the changes which accompany a successful struggle by the tissues against the tubercle bacillus. The polynuclear leucocytes are first engaged in phagocyting the invaders, but the lymphocytes and fixed cells evidently participate later in the process of disintegrating the bacilli. This appears to take place, at first, chiefly in the lymph nodes nearest their point of entrance into the body.

The digestive functions of the various leucocytes best account for the mechanism of resistance, but further than this surmises cannot safely go at present. (A further discussion of this subject as related to immunity is to be found on page 95.)

SUBNORMAL RESISTANCE—PREDISPOSITION

A true predisposition to tuberculosis would imply a *specific* lower resistance to this infection in particular. This is, at present, hardly more than an hypothesis, since in former times many of the indications referred to as specific, such as scrofulosis, later proved to be actual manifestations of previously existing infection. In view of this altered conception, one may more accurately denote a predisposition as *subnormal resistance* which may or may not be specific, inherited, or acquired, yet of great practical importance.

In contrast to normal cellular vigor, the cell functions may be weak or a deficiency of certain mature forms may exist, as found by Arneth ('05) with the leucocytes. He discovered that polynuclear cells con-

taining a large number of nuclei were diminished in persons in poor health. Likewise, Wright has found a lower opsonic index to the tubercle bacillus in "predisposed" persons. The normal serum antibodies, agglutinins, bacteriolysins, and opsonins are also weaker in persons fairly classed as subnormal in a clinical sense; hence the assumption that a changed condition of the blood fluids has an appreciable relation to lowered resistance is justifiable.

Much stress is laid by Robin and Binet ('01) and other French authors on a deficiency of the calcium and magnesium salts, and also of phosphates in the tissues as a result of increased respiratory activity which produces a greater interchange of CO_2 and oxygen. This "demineralization" theory of predisposition is related to others, such as that of Schulz ('02), who finds the silicates in the connective tissue lessened or variable in amount. Furthermore, the degree of alkalinity of the blood, as represented in the bronchial mucus, is considered a factor by Hesse ('03) in favoring or opposing the growth of tubercle bacilli. The well-known susceptibility of diabetics probably depends on the excess of sugar, whether directly or indirectly may be an open question.

Chemical conditions of the tissues cannot alone be considered a sufficient explanation of subnormal resistance, however important they may be, nor is there sufficient proof of their specific relation to the tubercle bacilli.

Influence of Sex.—Females at the time of menstruation, pregnancy, and parturition are physiologically less resistant; this is also true at the menopause. The evidence of such lowered resistance in females is seen in the development of latent tuberculosis into activity at these periods, but with pregnancy the converse may often appear in an arrest of a previously active process. Analogous physiologic changes in males have not been associated with tuberculous infection.

Inherited Predisposition.—The bearing of inherited weaknesses on the development of tuberculosis is apparently one of the most unmistakable facts in medicine, but a modification of former views has been inevitable as the rôle of infection in early life has become clearer. A differentiation has been necessary: first, between actual congenital disease, i. e., transmission of the bacillus *in utero* (see Hereditary Transmission); and second, a specific vulnerability of the offspring after birth. Close study has failed to establish the exact rôle of inherited disposition in this narrow meaning, yet statistical and experimental support has been forthcoming. On the one hand, there is an apparent racial susceptibility in the Negro and Indian which cannot be described as specific, since no evidence exists of the prevalence of the disease in former generations; while the converse seems true of the Europeans and Anglo-Saxons, whether due to gradual immunization or by the

elimination of the weaker individuals, both of which theories are plausible. On the other hand, the study of tuberculous families furnishes conflicting evidence of transmitted susceptibility. J. E. Squire ('97, '01) found that in 1,000 families only ten per cent more of the children of tuberculous parentage became tuberculous than those of non-tuberculous families in the same class of people, a difference easily accounted for by the greater chance for infection in the former. In the Faroe Islands the people have closely intermarried and had no outside opportunities for infection for many generations, yet no proof of inherited disease or susceptibility was obtained by Boeg ('05). Davies ('00), however, finds the much greater prevalence of tuberculosis on the Isle of Man attributable to close intermarriage, which may or may not be interpreted as conferring a specific susceptibility. The genealogic tables of Riffel ('06) and Leudet ('85) are made to support the latter theory, but are less conclusive. From the standpoint of biologic research Adami ('04) and Hueppe ('03) affirm a belief in transmitted specific vulnerability on the ground that the transmission of specific immunity implies the opposite as a quality of protoplasm subjected to a specific poison.

Experiments along this line have not been fruitful of results. From the maternal side the young of animals subjected to tuberculous toxins are said by Carrière ('00) and Sicolla and Palmieri ('96) to be more susceptible, yet it is evident that pregnant consumptives in the active stages of the disease are likely to bear weakling children anyway, and if the fetus is exposed to injury by the toxins it will likely be a short-lived infant. When the disease is not in an active stage in the mother, no toxic influence can be assumed to play a part, so that much less ground exists in such instances for a specific inheritance. Moreover, tuberculin susceptibility has not been proven to be transmissible. On the whole, a truly specific predisposition from maternal inheritance has no experimental basis, and from the paternal side there is much less warrant for a belief in it.

Inherited Structural Defects.—While specific characteristics referable to the cell protoplasm which constitute disposition are not readily discerned with our present methods of research, there are many abnormalities of structure and function which are inherited and may be acquired, that produce subnormal resistance to tuberculosis equal in importance to any assumed specific disposition.

The shape of the chest formerly had more attention bestowed on it than at present, yet clinical experience bears out the old idea that the shallow or pigeon-chested individual has a poor resistance to tuberculosis. On the other hand, Brown and Pope ('04) found no distinctive type in the chest shape of patients in the Adirondack Cottage Sani-

tarium, but who, as a rule, are selected because of a favorable prognosis. They did find, however, an average longer thorax than normal. Statistics of consumptives show about thirty-five per cent to have the phthisical form of chest, yet this is not enough to establish its prominence as a factor in causation unless we could exclude the cases in which it is secondary to the disease, a point generally disregarded in former studies.

The *habitus phthisicus* of Hippocrates was well recognized in olden times as a peculiar, flat-formed chest, with protruding scapulæ, in persons with long bones, delicate features, and blonde skins. A long neck, sloping shoulders, and defective muscular development about the chest, with relative immobility, were prominent features emphasized by Rokitansky ('46). Many years ago Freund ('58) found premature ossification of the first rib at the costosternal joint and shortening of the rib, frequently associated with apical tuberculosis, and ascribed this to the restriction of movement caused thereby. Hart ('06) has recently elaborated Freund's theory by an extensive pathologic study, and finds that it has much importance in causing a restriction of thoracic development and function at the apex. He considers it both an inherited and acquired maldevelopment of the costal cartilage of the first rib, which leads to an infantile type of apex, with proportionally greater anteroposterior diameter. Depression of the sternum, a restricted movement and diminished angle at the junction of the manubrium and gladiolus (Louis' angle) were associated with other anomalies by Rothschild ('00) in causing a predisposition to lung tuberculosis, but the studies of Hart failed to confirm this. (See Figs. 11 to 14.)

Brehmer ('85) was one of the first in modern times to study the functional defects in connection with a *habitus phthisicus*. He attached fundamental importance in the disposition to tuberculosis to a congenitally small heart with disproportionately large lungs. He conducted his sanatorium treatment with the idea of increasing the heart power, and by his success considered the correctness of his theory demonstrated.

Many other functional and structural faults have been brought into relation to tuberculosis in the same way. Among these may be mentioned changes in the number and quality of elastic fibers (Hess, '04; Tendeloo, '01–'02), deficiency of the thyroid gland (Lorand, '05), degeneration of the pneumogastric nerve (Mays, '00), and cerebral defects as found in imbeciles and markedly neurotic persons. Most of the inborn anomalies fall short as sufficient causes of predisposition when taken separately, and some, indeed, are probably acquired as the result of tuberculosis quite as often as they are inherited causative factors. This is true of small hearts, imperfect thoraces, and nutritional faults described by Landouzy ('99) and Mosny ('02, '03) as "paratubercu-

loses." It is, at least, hard to differentiate those which are due to inherited defects from those dependent on early and mild tuberculous infection; or, still further, those resulting from other diseases in the parents. Besides tuberculosis, syphilis and alcoholism in the parents are well known as potent causes of physical degeneracy in the children which render them subnormal in their resistance to disease in general.

Local Predisposition.—Certain tissues and situations in the body seem to be especially prone to tuberculosis, and while mostly explained by mechanical conditions, which favor the lodgment of the bacillus, there are suggestions of a greater adaptability for infection of the lungs, for example, as compared with the liver or muscles due to biologic differences in the cells. The predilection of the lung apices is explained in several ways: (1) by the slower air current favoring the deposit of bacillus dust; (2) by the irregularities and sharper angles of the bronchi in this situation tending to retain the secretions (Birch-Hirschfeld, '99); (3) a slower blood and lymph stream mechanically favorable to hematogenous infection, and because of the defective nutrition thus produced. Schmorl ('01) has located a fibrous groove in the pleura opposite the posterior segment of the first rib which is often associated with the anomalies of Freund and Hart previously mentioned, and which he regards as a local predisposition.

These anatomic theories, taken singly, are less tenable than the physiologic ones so ably presented by Tendeloo ('07) and which attribute the differences in vulnerability of the lung apices, as compared with other portions, chiefly to poorer nutritional conditions dependent on a slower blood and lymph flow, to restricted expansion and consequent slight atmospheric pressure changes, and to absence of venous stasis in the apices, the latter being unfavorable to tuberculous infection (see also Immunity).

Another explanation of apical lung disease which should be remembered is that an extension of lymphatic infection in the neck by way of the pleura is possible. Aufrecht ('05) has long held that infection of the lungs in particular is accounted for by infarcts caused by bacilli lodging in the small arterial endings. Von Behring ('06) inclines to the same view of primary lung infection, no other reason than the physiologic conditions of the blood circulation, which makes the lung act as a filter, being needed to account for a predilection for this organ. The same reasoning accounts for the development of foci in the kidneys and joints. On the whole, no satisfactory biochemic theory can be adduced which accounts for local predisposition, although there are such explanations for the relative immunity of some tissues, such, for example, as the stomach, where the presence of hydrochloric acid is inimical to bacteria. The endothelia of the alveolar capillaries and

serous membranes are, however, believed to have a special affinity for the bacillus poison by von Behring ('06) (see page 95). An apparent hereditary *locus minoris resistentiæ* has been observed by Turban ('00) in that the lung on the same side of the body as in the parent was first involved in the children of 19 out of 22 tuberculous families. This observation was confirmed in 78 per cent of 28 families among the author's ('02) cases. In one family where the father and four children were consumptive, the left lung appeared to be attacked first in all of them.

Acquired Predisposition.—In the absence of congenital defects or inborn weakness, there is no doubt that numerous causes are able to produce a temporary or permanent subnormal resistance to tuberculosis. These causes are frequently of greater importance than heredity and structural weakness because tuberculosis is no respecter of athletic constitutions temporarily made susceptible, and is oftener unconsidered in such persons, whereas greater care is bestowed on the weakling.

SPECIFIC SUSCEPTIBILITY FROM PREVIOUS TUBERCULOUS INFECTION

Lymphatic (*Scrofulosis*).—The question of primary and secondary tuberculous infections has become of increasing interest and importance during recent years, and largely through the observations of von Behring ('03) who attaches much importance to the ease of infantile infection and its remote consequences. It cannot be gainsaid that many young adults having pulmonary tuberculosis appear to have acquired their first infection in childhood, and subsequent infections led to the ultimate outbreak, or, as von Behring holds to be more probable, resulted from the latent bacilli which first found lodgment in the tissues.

It is highly important to contemplate the three possibilities by which von Behring explains the result of the inhalation or ingestion of tubercle bacilli in early life and their primary reception into the tissues. In the first place, they may be of sufficient number or virulence to produce immediate and fatal infection. Second, they may be able, because of less number or virulence, to produce only local disease in the lymph nodes or lungs, which accounts for scrofulosis and all its manifestations. According as the disease is more or less marked, it may or may not finally lead to lung tuberculosis after this incubation stage. Third, the virus may be so weak that no infection results, but a degree of increased resistance is established, after a period of susceptibility lasting several months has passed by. In this place we have only to do with the last two hypotheses, and more especially with the clinical evidence of a specific susceptibility under the name of a "scrofulous diathesis," as it is vaguely termed in the older medical works.

It is a complex matter at best since no clear distinctions can be made

between morbid processes due to the tubercle bacillus which set up chronic lymphoid hyperplasia and those due to other bacteria alone or associated with the tubercle bacillus. Clinically it is customary to distinguish between a tuberculous and nontuberculous scrofula only by the test of time, and yet all forms are clearly predisposing, or at least are frequently followed by some other form of tuberculosis. It is therefore proposed by many writers to abolish the term altogether and class all cases as lymphatic tuberculosis. Nevertheless, it seems to the writer justifiable to retain it for nontuberculous lymph-node affections produced by the streptococcus and other pyogenic organisms, which are assumed to exist, and certainly prepare the soil for the tubercle bacillus. For the practical application of preventive measures, it is needful, therefore, to consider scrofulosis as a strong predisposing factor.

Pulmonary.—An important practical question connected with former attacks of pulmonary tuberculosis concerns the danger of reinfection after the clinical healing of the disease, or in subjects with so-called latent pulmonary tuberculosis. Little proof has been produced that a special disposition to external infection is brought about by the first attack, yet it must be acknowledged that secondary autoinfection is frequent in the lungs, larynx, and intestine, as well as in other organs of individuals with open disease. It should be recalled, however, that under these circumstances any weak moment, whether due to existing tuberculosis or not, may play the part of a predisposition, when great numbers of bacilli are ever present and ready to enter. On the other hand, the tendency to localization at the point of entrance into the mucosa is regarded as a sign of resistance by von Behring (see page 93), and may repel a secondary infection from outside sources more vigorously than normal, particularly in adult life under natural exposure.

So far, then, as can be proved, the rôle of a specifically acquired susceptibility in favoring a fresh infection from without is at most very slight and not supported by animal experiments, while the reverse effect —i.e., an acquired protection, has an experimental basis (see Immunity). On its face this statement appears wholly contradicted by the clinical observation of successive attacks of pulmonary tuberculosis in subjects previously healed in the clinical sense. Yet it must be remembered that most of these relapses can be traced to autoinfection from an old focus and not to new bacilli from outside. Moreover, the idea of multiple cumulative infections in children exposed to family tuberculosis is not necessarily incompatible with a relatively increasing though insufficient resistance to external infection.

The exact truth about specific susceptibility may require years of further observation to settle.

NONSPECIFIC SUSCEPTIBILITY

Infectious Diseases.—The other infections preceding or following the reception of tubercle bacilli into the body are probably the most important factors in predisposition. In childhood the familiar picture of meningeal and lymphatic tuberculosis following the exanthematous diseases needs no comment. Measles and whooping cough most frequently lead to acute outbreaks of tuberculosis; tonsillitis, diphtheria, and influenza to the scrofulous types of the disease in the young. The rôle of these infections in adults, if not also in older children, is doubtless more often that of spreading a preëxisting latent tuberculosis.

Influenza comes first in this class, comprising an antecedent history in 15.5 per cent of 1,690 of the writer's cases where an exciting cause was referred to, while colds were recorded in 22.2 per cent as forerunners of the onset of tuberculosis.

Pneumonia and pneumococcus infections in general are associated with the etiology of pulmonary tuberculosis, but to what extent is not known. The principal difficulty arises in deciding whether lobar pneumonia precedes or accompanies the pneumonic form of tuberculosis, or whether the latter is quite independent of it. A history was obtained in nearly six per cent of the cases collected by Jacob and Pannwitz ('01–'02), and in six and a half per cent of the writer's. In many cases the diagnosis is too indefinite to make the estimates accurate.

Pleuritis.—A history of a former pleurisy as an independent affection, either dry or exudative, was given by eleven per cent of the writer's patients. Such a large proportion of pleurisies have been found tuberculous in recent years, if one may judge by the results of the tuberculin test, that but little value can be given to such figures as an evidence of predisposition. Streptococcus and pneumococcus pleurisies, nevertheless, are probably locally predisposing. The subacute and chronic catarrhal respiratory affections, such as tracheobronchitis, when not symptomatic of tuberculosis are difficult to bring into a causative relation to it.

Bronchitis was a history in three per cent of the writer's cases, most of which were doubtless symptomatic. In the upper air passages the nasal obstructions, adenoid hypertrophies, and atrophic changes of the mucosa which are the sequelæ of various acute infections probably play a more important part than the catarrhal processes *per se*.

Typhoid fever is so often confused with tuberculosis that its relation to it is hard to establish. In 4.2 per cent of the writer's cases a history of alleged typhoid was associated with the tuberculosis. It could hardly fail to be an occasional factor, especially in infection by way of the intestine.

Acute gastro-intestinal catarrh is in the same category with typhoid as a means of producing conditions favorable to intestinal infection, particularly in infants.

Malaria was mentioned as a causative factor by 2.09 per cent of the writer's patients. Such histories depend chiefly on the presence of malaria in the region in which these patients reside. The symptoms of tuberculosis are, no doubt, very often mistakenly attributed to malaria because of their similarity. Hence but a small rôle can be given to it in predisposition when measured by such standards.

Rheumatic fever is rarely followed by tuberculosis, and the heart complications resulting in passive congestion are thought to act antagonistically to it (see page 92).

Of the venereal infections, *gonorrhea* and *syphilis*, both are frequently associated with tuberculosis, but whether as especially aiding its development may be doubted. In fact, the erroneous idea that syphilis is protective has been held (Portucalis, '99). *Syphilis* was present in 1.3 per cent of the writer's private cases, but in a large series of hospital cases from 3 to 6 per cent are recorded (Sargent, '07; Mauthé, '00–'01). Association with depraved habits which are equally harmful to health, and the large percentage of venereal diseases in the nontuberculous, renders a decision as to its importance impossible. *Gonorrhea* is said to favor localization of the bacilli in the kidneys, bladder, and testes; otherwise it acts only as a debilitating factor in general.

Diseases of Nutrition.—*Diabetes Mellitus.*—One of the most serious predispositions from diseased conditions is conferred by *diabetes.* Over one quarter of its victims among young persons die of tuberculosis. A chemical basis is assumed for this susceptibility in that sugar favors the growth of tubercle bacilli, but other elements may be associated. *Rachitis* is probably the most important, next to diabetes, in favoring infection, because of the combination of thoracic deformities and defective development in general. Turban ('99) found 10.8 per cent of his cases of this type; the writer found only 3 per cent, but in the latter were included only those cases with marked deformity dating from childhood.

Gastric and intestinal dyspepsias and chlorosis are too often symptomatic of tuberculosis and other diseases to be classed as predisposing in themselves, though this cannot be denied of them.

Nervous Diseases.—*Epileptic* families are very frequently tuberculous, while neurotic persons in general easily fall victims to tuberculosis. No direct connection can be assumed, but malnutrition accompanies nearly all of these affections, and is sufficient to account for their association.

Insanity.—Tuberculosis carries off from thirty to forty per cent of melancholics and maniacal insane persons. The fasting and confinement, combined with opportunities for infection and traumatism, have much importance here.

Miscellaneous.—*Nephritis* is occasionally antecedent to tuberculosis, but of doubtful connection with it in a causative way. *Cancer* is also occasionally mentioned as one cause acting by its debilitating effect. *Eczema* and other skin diseases may be included with predisposing factors by leading to inoculation from scratches, etc.

Injuries (*Traumata*).—Blows on the chest or concussions, as in railway accidents, athletic contests, or violent strains, are capable of bringing to light a latent tuberculosis. Contusions and the consequent extravasations of blood make a good soil for tubercle bacilli which may be lurking there at the time and gain access to the part through the blood. Thus joint and meningeal tuberculoses are rightfully associated with blows or falls. Severe nervous shocks and overstrain may here be included. The occurrence of tuberculosis among American college athletes is also significant in this connection.

Surgical operations may give the impetus to a slumbering disease which is thus wakened to activity. This is occasionally seen after operations on tuberculous lymph nodes, for appendicitis and other abdominal diseases. In thirteen of the writer's cases appendicitis with operation seemed to be connected with a subsequent tuberculosis. Aspiration of a pleural exudate and section of a *fistula in ano* have sometimes been followed by miliary tuberculosis, presumably produced by the opportunity given for a large number of bacilli to get into the lymph circulation.

INCREASED RESISTANCE

Physiologic.—By appropriate measures persons of subnormal vigor may enhance their resistance to tuberculosis. One of the most important is to increase the digestive power and assimilation of food. Proteid and fatty foods are especially adapted for this purpose, and are the ones usually least preferred by the so-called predisposed individual. Suitable muscular and mental exercises promote resistance, while recreation in the open air and athletic sports in moderation aid greatly.

Occupation.—Open-air occupation increases the resistance of the respiratory tract to changes of temperature, and promotes heart power. Coal miners are said to be relatively immune because the dust lodged in the lungs creates an unfavorable soil for the bacillus—an improbable explanation. Likewise, it has been alleged that sulphurous-acid fumes formed in wood-pulp manufacture, the ammonia from stables, and the balsamic emanations in the forests act directly as a protection by their

antiseptic qualities. Such theories are no longer worthy of attention, the freedom from infection, if any, being attributable to absence of other conditions necessary to bring it about.

Diathetic.—A familiar observation is the relative immunity to tuberculosis among lithemic individuals. The gouty diathesis also appears to promote chronicity in the disease, when present. On the theory that an excess of the products of nitrogen metabolism are in the blood, and make an unfavorable soil for the bacillus, the administration of urea was advocated by Harper ('01) as a therapeutic agent.

Diseases.—*Mitral Heart Disease.*—The supposed antagonism from mitral heart disease, accompanied by venous congestion of the lung, rests on clinical observations of arrested pulmonary tuberculosis in individuals who have this complication. Whether an actual antagonism to infection from this cause really exists is questioned by G. W. Norris ('04) as the result of a collective study of pathologic material. The excellent results of Bier, who introduced the treatment of localized tuberculosis on the theory of venous stasis, nevertheless incline to support the above explanation.

Emphysema and asthma are supposed to confer some protection on individuals who suffer from these maladies. If they are not already symptoms of tuberculosis of a chronic type they may act by venous congestion, as in mitral insufficiency, to which some cases are related anyhow.

Specific Increase of Resistance.—The possibility of an hereditary resistance acquired by certain races has already been referred to (page 83). If its existence is admitted, it is less discoverable in the individual than in the race or family as a whole.[1] There is more reason to assume a gradually acquired resistance after birth, which amounts to immunity in those individuals who were unquestionably exposed to the infection without evidence of infection having ever occurred. To this class possibly should be added those numerous instances of slight localized infections which leave cicatrices in the lungs or lymph nodes. On the other hand, it cannot be assumed that a specific resistance, developed for a time by exposure to a harmless infection, necessarily persists beyond a limited period, especially when only fibrous or chalky remains of the transient infection are present. Fortunately, during good health adults enjoy a large degree of natural or acquired resistance, judging from the rare development of the disease under such conditions of exposure as serve to infect weaklings and children.

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[1] Reibmayr ('94) attributed the more benign course of tuberculosis in England and Germany to a decreasing virulence due to a gradual immunizing process in these races.

In the families of sufferers from "inherited" tuberculosis in the old meaning of the term, there is found some support for the idea of a partial immunity, inherited or acquired from parental sources. This is observed in the greater chronicity and duration of the disease in such families, and has been used as an argument both for the inheritance of the disease and a special resistance to it. The acquisition of lymphatic or bone tuberculosis early in life, which is mild in character, as a rule, is often followed by a very mild type of pulmonary tuberculosis. It is, therefore, not necessary to attribute the increased resistance to an inherited influence, as early infection is the rule in family tuberculosis. The late Dr. Edwin Solly ('95), of Colorado, made the interesting observation in his patients that more lasting "cures" or chronic forms among pulmonary cases occurred among those with a history of family tuberculosis than those without it. Turban ('99) noted the same thing, while H. M. King ('01) found the course of the disease a year longer in 103 carefully recorded fatal cases of tuberculous parentage. Previous acute attacks of tuberculosis may fairly be associated with the more chronic course of relapses, especially those in advanced age, as manifestations of specific resistance.

The chronic course of lupus is also assumed by von Behring to be a sign of resistance in a previously infected "scrofulous" person who acquires an added infection which localizes in the skin because of the relatively immune lymphatic system. If true, it is an illustration that partial immunity, although conserving life, is not always desirable for the individual.

IMMUNITY

To use this term literally in connection with tuberculosis is unwarranted by any experiences of a clinical or experimental character thus far obtained. The possibilities of complete immunity under all conditions of natural exposure and experimental inoculation may well be doubted; but the suggestions of relative auto-immunity, mentioned in the preceding paragraph, combined with the slowly evolved conviction from experimental research, have produced a belief in the possibility of a high degree of *relative* immunity against tuberculosis. This fact gives hope for its future application in the prevention of tuberculous infection in the human race, a matter of transcendent interest and importance. At present enough is demonstrated of the value of immunization in bovines to make certain that when methods are perfected, it should not only apply universally to animals but to human beings as well.

Experiments.—The history of experimental research in tuberculosis during the past fifteen years has much to do with attempts to protect

animals against the disease by vaccination with bacilli, sterilized or weakened in various ways by the use of extracts, or of varieties other than those capable of infecting the given species to be immunized.[1] A certain degree of success was attained at the beginning of these studies by Dixon ('89), Koch ('90), Klebs, Grancher ('90), Hericourt ('92), and Trudeau ('93) on guinea pigs and rabbits. Later de Schweinitz ('03) and Trudeau ('03–'06) found a very high resistance established in guinea pigs by inoculations of bacilli of weak virulence, while still later MacFadyen, von Behring, and Pearson ('02–'06), and Gilliland ('02) simultaneously found that cattle could be protected by inoculations of human bacilli. Koch, Neufeld ('04), and Schütz ('03) also established the same fact. Methods by which success was obtained in diphtheria and tetanus were found of no avail by the majority of investigators. Maragliano ('95, '04, '05) has been the chief exponent of antitoxic methods, and more recently Marmorek ('03–'04) has claimed successful results by means of sera, but the proof has not been convincing. Preparations of dead bacilli confer some degree of immunity, but the greatest success has been obtained by living bacilli in a feebly virulent condition. All soluble extracts have failed to excite a specific immunity, although they give rise to certain antibodies in the serum of injected animals. In his painstaking researches over a decade ago Koch ('97) came to the conclusion that the washed body substance of pulverized bacilli (T. R.) of virulent strains was the best immunizing agent. Von Behring ('07), in his latest published statements, considers that partly extracted "Rest" bacilli, treated with chloral hydrate and other salts, produce the best results. The problem seems in a fair way to be solved by these diligent studies.

Application.—*Cattle.*—The immunization of young calves has been carried on rather extensively in Germany and Austria by the "bovo-vaccine" method of von Behring, which consists of one or two intravenous inoculations of human bacilli cultures. These have been passed through guinea pigs before cultivation for the preparation of vaccine, and are dried before use. The bacilli are not sterilized, but weakened by desiccation. Pearson has been the pioneer in this field in America, and has applied intravenous human bacilli inoculations in Pennsylvania to a large number of cattle, and demonstrated the value of the method by exposing immunized calves to natural infection together with unprotected animals, and with complete success in preventing infection in the protected animals. The tuberculin test and post-mortem examinations established this beyond a doubt. Valuable confirmation has also

[1] A review of these experiments is presented by Pearson in the Second Annual Report of the Phipps Institute.

been furnished by Calmette and Guerin ('06) and Vallée ('06) in France, who carried on similar tests, and furthermore found that calves could be protected by feeding the protective virus in milk.

The chief drawback in the immunization of cattle at present is in the use of living bacilli which, though harmless for cattle, may remain latent in the tissues and be a source of danger in the flesh and milk. If the later preparations used by von Behring, "tuberculase" and "tulase," which are claimed to have all the properties of living bacilli except the power to grow, shall prove to be equally as good as the living virus, a great advantage will be gained. The application of specific immunization to man will then logically follow. It would be unsafe to predict the limitations of its use at present, or the duration of the protection. No facts are available as yet to answer these questions, but even if the protection is but a matter of months, the period of greatest danger, according to present views of primary infection (that of childhood), might be tided over when by the growth of natural resistance virtual immunity is assured.

Explanation of Mechanism.—The study of immunity problems in general has brought aid in the understanding of the reaction of the animal tissues to a tuberculous infection. The tubercle, as a unit, has also much in its structure, reactions, and transformations that interprets the resisting mechanism of the body cells. Stress must be laid at present on the leucocytes and lymphoid tissue as being subject to changes during the immunization process, by which a more vigorous defense is presented to invading bacilli. The condition of tuberculin susceptibility is apparently a necessary phase of immunity, and may exist, according to von Behring, without the presence of tubercles, owing to functional alterations in the lymphatic tissues and endothelia of arteries and serous membranes. However this may be, the eye inoculations in the immunized rabbits in Trudeau's ('93) experiments resulted in a massive leucocytosis and more marked congestion than in control eyes, and with eventual healing.

The evident destruction of the bacilli by the leucocytes, or at least their presence in greater number, points to a lytic function in the cells since the serum alone fails to reveal it. It is presumable, then, that so long as the susceptibility lasts there is heightened phagocytic and lytic power. Whether at the same time tolerance is developed for the toxin set free in the blood and in these cells surrounding the bacilli or the tubercles, is more doubtful. Only when no local caseation, general disturbance, or cachexia follows the death of the inoculated bacilli—i. e., a toxin immunity—can a satisfactory degree of protection be considered established. The assimilation and transformation of the endotoxin by certain chemical groups in the body cells which have an affinity

for allied groups in the bacilli, is, in essence, the explanation for the immunity phenomena given recently by von Behring, who has made a most thorough study of the problem. In the actually diseased individual but little impression is made on the cells outside of the aggregation about the tubercles until the malady has progressed to an advanced stage. Then increasing resistance may seem to be developed gradually and lead to an arrest or chronicity of the disease. Such immunity comes too late to be efficacious in saving life, but by influencing the cells outside the tubercle artificially during favorable stages of the disease one has the best rationale for the use of immunizing tuberculins, as introduced by Koch and von Behring.

SPECIFIC SUBSTANCES IN THE BLOOD

Agglutinins and Precipitins.—The most prominent change discoverable in the blood of animals injected with bacilli or extracts of the same is the development of agglutinating or precipitating power for them. Its significance appears to be no greater than in other diseases, and it does not seem necessary to immunity. On the contrary, quite strong agglutination power may be present without immunity. It is probable that this function tends to localize the infection and that the precipitins are practically identical in effect.

Opsonins were demonstrated by Wright as reaction products concerned in immunity, which aid in the process of phagocytosis. The specificity of this function in tuberculosis has been demonstrated, but its apparent independence of the agglutinating function is not to be assumed as yet. The opsonic index, as a measure of resistance, is of uncertain value in actual use thus far, yet in the hands of its discoverer tuberculin treatment is claimed to be more successfully administered by its guidance.

Antitoxins have not been demonstrable by the usual methods in vogue with diphtheria, etc., except in the hands of Maragliano ('95), Marmorek ('03), and a few others. The development of true antitoxin for tuberculosis is *a priori* unlikely, inasmuch as the bacillus resembles typhoid, streptococcus, staphylococcus and other bacteria, etc., in which cell endotoxins, as distinguished from secreted toxins, play the principal part of the disease. To this class of toxins the antitoxic or neutralizing properties of the tissue cells are not free in the serum, so far as has been proved. Antibodies having two affinities (amboceptors) have been demonstrated in the serum by Widal and Le Sourd ('01), Camus and Pagniez ('01), and the writer ('04). These are not true antitoxins in the sense of diphtheria and tetanus, but are apparently related to the agglutinin or opsonin.

Antituberculin was assumed by Wasserman and Bruck ('06), who examined the serum and tissues of tuberculous subjects, to be an antibody set free from the tubercles by the secreting cells surrounding them. By the method used to identify it, differentiation from the agglutinins was not established.

Lysins.—While lytic processes exerted on tubercle bacilli can be proved to take place in the tissues, the serum does not reveal such powers as does typhoid immune serum. In the disintegration of tubercle bacilli, the leucocytes are doubtless most important, but test-tube experiments here also fail to give information of value. The highly resistant wax composing such a large part of the bacillus is readily imagined to be difficult to dissolve and digest, and the process is doubtless slower than with most other bacteria for this reason.

SUMMARY

The biologic processes of specific immunity against tuberculosis are at least twofold: (*a*) a bacteriolytic function, involving in all probability agglutinating and opsonifying action by the serum; (*b*) a toxin-binding or digesting function which establishes tolerance after a period of susceptibility, provided the amount is correctly adjusted to the capacity of the individual's cells and their nutrition is well maintained.

ADDENDA

Summary of Predisposition and Immunity, Presented at the International Congress, held in Washington, D. C.

Of the contributions presented to the International Congress of Tuberculosis at Washington, those bearing on the subject of predisposition and immunity should here be noted.

The "demineralization" theory of predisposition has found a new supporter in this country. An explanation of increased calcium excretion in tuberculosis is given by the studies of Croftan which tends to emphasize the importance of this element in neutralizing the fever-producing albumoses set free by the disease.

Several valuable contributions have been made to the subject of inherited predisposition. To be mentioned particularly is the work of Prof. Karl Pearson, who has made a more careful study in recent years of family tuberculosis, and comes to a conclusion decidedly favoring the theory of hereditary predisposition.

Szabóky collected statistics from 1,456 tuberculous and 1,433 non-tuberculous individuals from which he determined that hereditary predisposition was of equal importance to acquired disposition. The largest proportion of the tuberculous had an inherited taint which was one half from the paternal and the other half from the maternal side. In a third of the cases the disease showed itself in the parents before the birth of the children. A small percentage had tuberculosis in grandparents, and the least in brothers and sisters.

Von Unterberger explains a transmitted specific vulnerability by qualitative differences in the embryonic chromosomes.

Hart has continued his studies of structural anomalies of the upper thoracic aperture, and maintains his views as to their importance as a predisposing factor.

This predisposition is at first local and holds for any manner of infection, whether by inhalation, blood, or lymphatic routes. This leads to the development of the first foci in the apices. Disarticulation of the first rib cartilage has been seriously proposed as an aid in overcoming this disposition (Harrass, '08).

The theories of Hart as illustrated in the accompanying photographic reproductions (Figs. 11 to 14[1]) have the best claim to recog-

[1] These four excellent radiograms have been kindly supplied by Dr. Carl Hart and are reproduced from original photographs with his permission and through the courtesy of his publishers, F. Enke, Stuttgart. (See Bibliography, Hart, '06 and Hart and Harrass, '08.)

Fig. 11. — Normal, Well-Developed Upper Thoracic Opening with Good Pronunciation of Paravertebral Spaces. Marked age ossification of costal cartilages.

Fig. 12.—Typical Stenosed Upper Thoracic Opening with Asymmetry. Primary deformation of ribs. Sheath forming ossification of cartilage. Transition of the higher human form, the longitudinal oval, to the lower mammalian form, the transverse oval. Absence of lateral posterior spaces. Pressure of ribs has caused Schmorl's furrow in lung tissue.

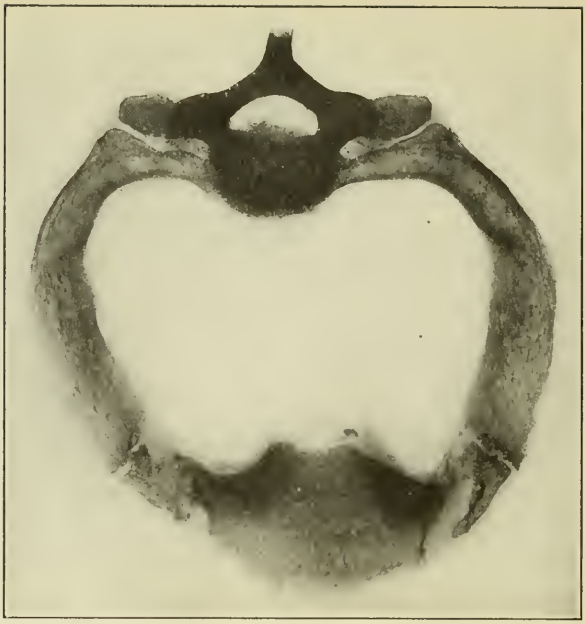

FIG. 13.—ASYMMETRICAL THORACIC OPENING WITH SLIGHT SCOLIOSIS OF CERVICAL AND UPPER THORACIC SPINE. Abnormal shortness of costal cartilages with sheath forming ossification.

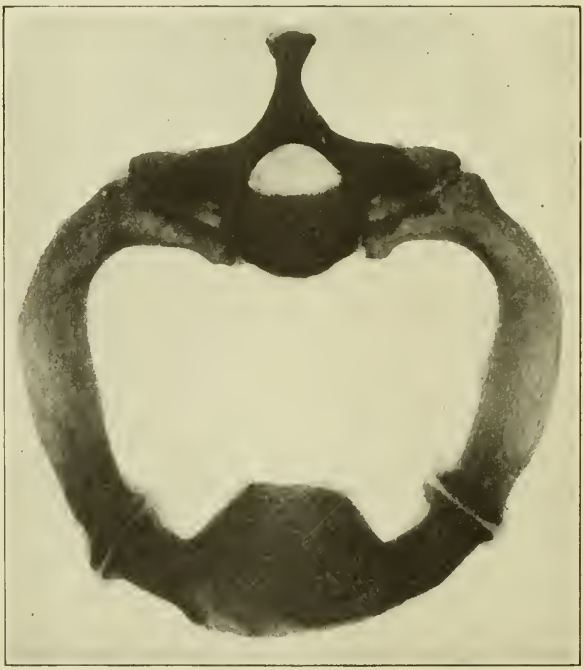

FIG. 14.—FORMATION OF TRUE JOINTS WITH EPIPHYSES AND CAPSULES. Total senile ossification of first costal cartilage. Healed tuberculous foci in lung.

nition in explaining apical tuberculosis where anomalies exist in the thoracic structure.

Under the name of "asthenia universalis," Stiller describes similar defects, including enteroptosis and floating tenth rib due to congenital absence of the tenth costal cartilage.

A contribution to the fact that tuberculosis is a potent cause of mental degeneracy is to be found in the statistics of 6,000 cases reviewed by Barr, from England and America. In the former tuberculosis was placed second and in the latter third in importance as etiological factors.

The familiar effects of strain, both physical and mental, in bringing latent tuberculosis to activity are certainly logical reasons for the belief that they frequently prepare the soil for infection. No better argument for an eight-hour working day is needed than the importance of tuberculosis preventive measures.

The classic experiments of Charrin and Roger, where animals which were made to overwork on treadmills showed lessened resistance to infections, illustrate the principle clearly.

The effects of worry and care are equally potent when combined with overwork and great responsibilities.

Special dangers are associated with dusty occupations, such as stonecutters and metal polishers. Organic dust is of less importance, but in statistics can be shown to bear some relation.

Hoffman has collected an interesting table of thirty dusty occupations showing the increased incidence of tuberculosis in them.

Experiments with the purpose of inducing artificially immunity in animals have been continued, but the problem is not yet sufficiently solved to warrant any positive assertions about the value of these methods.

Recently certain oleate soaps have been found by Noguchi to have restraining or bactericidal properties for tubercle bacilli which render them useful for immunization, while the studies of Bartel on the modifying influence of lymphoid tissue on their virulence which serves the same purpose, are at present hopeful fields of research.

A method to prevent the danger by inclosing the living bacilli in capsules which are permeable for the poisons, is employed by Heymans. The capsules are introduced subcutaneously or intraperitoneally, and are claimed to confer a high degree of protection.

Klimmer, of Dresden, claims equally good results from subcutaneous inoculation of living cultures of human type which are modified by passing through lizards, so as to lose their virulence for mammals.

Enough experience has been gained at present to show that the protection of calves is of limited duration. From six months to a year after vaccination exposure to infection is well resisted. Afterwards

bovine tuberculosis may be readily inoculated or acquired in infected stalls.

It is therefore plain that repeated vaccinations would be required to maintain the resistance, at least until the maturity of the animal fortified by previous vaccinations was a sufficient safeguard.

It has also been noted that for two months after the immunizing inoculation a state of lowered resistance exists, during which time protection from infection is important. Altogether the outlook for a practicable vaccination against tuberculosis is fair, though subject to some limitations.

Many new theories have been offered as explanation of the mechanism of immunity. Of interest are the experiments of Opie, pointing to a proteolytic enzyme activity on the part of the leucocytes surrounding or containing the bacilli.

Of interest also are the recent experiments by Calmette, which have shown that the serum of cattle and of man during the earlier stages of the disease will act as complement in completing the hemolysis of erythrocytes saturated with cobra venom. This property is said to be absent from the normal serum and in the acute or advanced stages of tuberculosis. The substance is thought to be an antibody of the nature of lecithin.

PART II

FREQUENCY AND DISTRIBUTION

CHAPTER I

FREQUENCY OF TUBERCULOSIS

By ARNOLD C. KLEBS

GENERAL CONSIDERATIONS

That tuberculosis is a very frequent disease and that it seems distributed over the civilized world is now a more generally understood fact, since many painstaking investigations have supplied the data for information. Whether such investigations, however, can ever furnish exact results, as almost every text-book or monograph attempts to show, must be viewed with grave doubt. All collective information on frequency and distribution of a disease is naturally based upon individual information, and in chronic diseases it is almost entirely supplied by mortality figures. Individual judgment as regards diagnosis is subject to error, and in official returns is often influenced by outside factors, and mortality statistics cannot give exact information as regards the importance and disability-producing qualities of a given disease, since it counts only the dead and not the wounded. These general considerations do not allow us, however, to set aside all statistical informations, only it is essential, in order to get a clear conception of actualities, to weigh very carefully the source of information before basing conclusions thereupon.

As regards the frequency of tuberculosis the paradoxical statement may be safely made that tuberculous infection is enormously frequent, affecting at some time almost everybody in a civilized community, while the disease itself, in a health- and life-threatening degree, is relatively much rarer.

FREQUENCY IN AUTOPSIES

An examination of all bodies would undoubtedly give the most accurate information as to the frequency of tuberculosis in the human race. Under present conditions, however, only a very insignificant number of all dead comes to autopsy, varying in different countries in accordance to a greater or lesser public prejudice. In this country large series of postmortem examinations are not obtainable, and for the required information one has therefore to turn to the countries of the European

Continent, where autopsies are more frequently performed—as a rule, on all those who have died in hospitals. The hospital population, of course, does not typically represent the whole population, especially not as to age distribution and social condition. Its largest contingent is furnished by the working classes. For this reason it has been maintained (Cornet, '07) that it is entirely erroneous to base calculations about the frequency of tuberculosis among the people at large upon tuberculous findings in autopsies. But since tuberculosis forms particularly a problem of the working classes, and since they undoubtedly constitute the vast majority, information derived from an investigation among those classes not only touches, but throws the strongest light on the situation as it is. On the other hand, it must be borne in mind that only the sick enter the hospitals, and of these only those dying form the basis of such investigations; also, that in some of these hospitals a considerable number of consumptives find admittance. There is therefore a good reason for the assertion that the percentage of tuberculosis found among such a material is not applicable to the population at large.

As pointed out recently by Beitzke ('09), a final decision about the frequency of tuberculosis is at present impossible. This applies with equal force to the calculations by which the frequency is most usually determined, based upon death certificates and clinical observation. But while a final decision cannot be formed, one sufficiently accurate for the practical appreciation of the magnitude of the tuberculosis problem can be deduced from observations made. The principal question as to what is to be considered tuberculous and what not has given considerable trouble not only to the statistician compiling death certificates, but also to the pathologist. Relatively slight divergencies in opinion as to what lesions are to be regarded as tuberculous often are responsible for the figures obtained by different observers. It is also true that the results of the more recent serial examinations cannot be compared with those of earlier times, because of late a more diligent search has been made for tuberculous lesions. And it is well demonstrated that it requires special training to discover tuberculous lesions. The discovery of healed and apparently insignificant lesions is not irrelevant, as has been held, because only through a painstaking study of the manifold reactions caused by the tubercle bacillus within the tissues can the real significance of the disease be determined.

The most important contribution to this subject was made by Nägeli ('00). He investigated 500 bodies with particular attention to tuberculous lesions, and found a greater frequency of tuberculosis than was previously found in a smaller number (100) of autopsies performed by Hanau and Schlenker (66 per cent). His figures have been widely

quoted, and substantiated by some and repealed by others. The difference in the figures obtained by later observers seems to be due less to a varying frequency of tuberculosis in the districts where the examinations were made than to different methods of investigation and also of classification. The strongest corroboration of Nägeli's findings was made by Burkhardt ('06). His investigations were made in 1,452 autopsies of patients who died of various diseases in Schmorl's clinic at the Dresden hospital. He used the same methods Nägeli employed, except that he did not include as tuberculous "slaty" indurations and simple adhesions and scars of the apex unless there was distinct reason for doing it. Probably, therefore, his figures are somewhat lower than Nägeli's. Outside of lethal tuberculosis he distinguishes (1) latent-active tuberculosis, which was not the cause of death, and in this definition he includes all fresh caseations in the lungs, glands, or elsewhere; (2) latent-inactive tuberculosis, as the former being found accidentally, and consisting in calcifications (cicatrization and "slaty" induration only when distinctly tuberculous).

Cornet has raised an objection against including as tuberculous calcified foci, because they contained no virulent bacilli, an assertion recently disproven clearly by Lubarsch ('08).

The findings of Burkhardt are best illustrated by the accompanying chart (Fig. 15), which shows the distribution of tuberculous findings in the various age groups. It is seen here that tuberculosis proves most dangerous (53 per cent) in the most active years of life—i. e., between eighteen and thirty—a circumstance noted also in general mortality statistics. Another acme of lethality is reached between the ages of five and fourteen. This latter feature is absent in the curve obtained from percentages of mortality, probably because of a different nomenclature used at those ages on the death certificates. The curve of the cases in which tuberculosis was the cause of death descends gradually but distinctly from the thirtieth year on. It is very probable that this descent would not be as marked in a much larger material. The total number of cases at the more advanced ages is too small to give reliable percentage figures.

Of great interest is the curve indicating total tuberculous findings. Its gradual rise up to 96 per cent (Nägeli, Burkhardt 92 per cent), between the ages of twenty and ninety, while the fatality curve gradually descends, indicates that while with increasing age tuberculous infection takes place more frequently, its danger decreases for the individual. Translated into plain language, this would denote that all adults harbor in their bodies evidences of tuberculous infections. Beitzke ('09), on the basis of his findings in 1,100 autopsies of a similar material (Charité, Berlin) examined by the same methods and

with a similar classification as the one used by Nägeli and Burkhardt, believes that only about 50 per cent of all persons become infected.

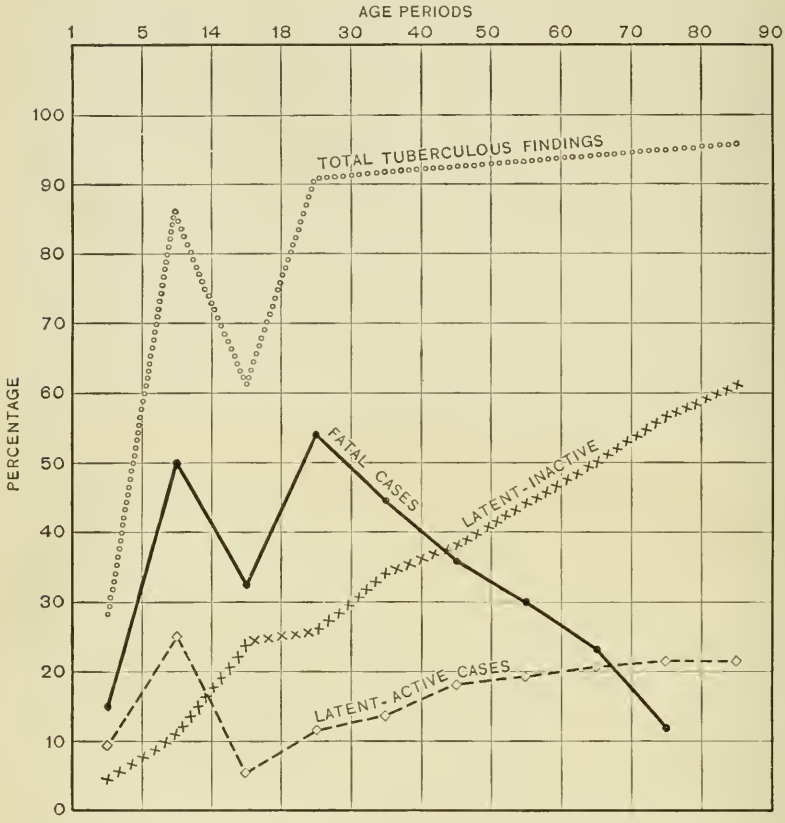

Fig. 15.—Distribution of Tuberculosis at the Various Age Periods (per 100 cases at the same ages) in a Series of 1,400 Autopsies. (After Burkhardt, '06.)

He agrees, however, with the other observers, that of those who are examined postmortem at metropolitan hospitals, this is the case in practically all adults.

AUTOPSIES IN CHILDREN

Most of the examinations so far cited include only comparatively small numbers of children. The question as to frequency of tuberculosis among them has received distinct attention in the last years, and has brought forward most significant data. Also here we find a great divergence of figures, not explainable altogether, as has been done again and

again, by different local conditions. A slight variation of method will alone alter the percentage figures very considerably. In reviewing them, this must always be borne in mind.

The following table will give a good survey of the various findings:

Author	Age of Children	Number of Autopsies	Number of Tuberculous	Per Cent Tuberculous
Müller ('89)	0 to 15 yrs.	500	209	42
Councilman, etc. ('01)	?	220	35	16
Baginsky ('02)	?	806	144	18
Orth ('04)	0 to 15 "	435	43	10
Nägeli ('00)	0 to 15 "	88	15	17
Burkhardt ('06)	6 weeks to 15 "	190	72	40
Hamburger and Sluka ('05)	0 to 14 "	401	160	40
Hamburger-Ghon ('07)	0 to 14 "	848	335	40
Sehlbach ('08)	0 to 14 "	1,423	180	13
Beitzke ('09)	0 to 15 "	397	54	13.6

The variations in these findings are quite startling. The influence of method has already been mentioned as one cause for them. Another one must be found in the greater or lesser number of very young children (under one year of age) which help to make up the total figures. Thus Beitzke, for instance, finds these relations:

Age	Number	Tuberculous	Percentage
Newly born	199	0	0
0 to 1 year	109	11	10.1
1 to 5 years	63	26	41.3
6 to 15 years	26	17	65.4

If he, therefore, subtracts from his material all children under one year of age, his figure for tuberculosis frequency would be 48 per cent. If the same thing is done in some of the other statistics we would have: Müller, 44; Hamburger and Sluka, 55; and Sehlbach, 40 per cent.

A special search for tuberculous lesions in early childhood in larger series of autopsies has been made in few instances only. Quite recently Martha Wollstein ('09) has analyzed the autopsy material of the New York Babies' Hospital. This hospital admits only children under three years of age (78 per cent under one year). The analysis embraces 1,131 autopsies. In 185 (16.4 per cent) evidences of tuberculosis were detected. She compares her results with those of Hamburger-Ghon ('07) during the first year of life in the four quarters, as follows (Hamburger, 318, Wollstein, 882 autopsies):

	First	Second	Third	Fourth
Hamburger	4%	18%	23%	
Wollstein	1.8%	11%	16%	23%

For the second year: Hamburger (179 autopsies), 40 per cent; Wollstein (192 autopsies), 34 per cent, first half; 44 per cent, second half.

It is not the place here to try to explain the reasons for the very rapid increase of tuberculous findings with advancing age. It is interesting to note, however, that the two series of figures from New York and Vienna pursue a remarkably parallel course.

FREQUENCY INTRA VITAM

Since the discovery of the existence of hypersensibility to tuberculin in tuberculous individuals, new light has been thrown on the frequency of tuberculosis. Here, also, the results vary according to method used and cases selected. But in general it can be maintained that the tuberculin findings corroborate those obtained at autopsy. Thus Franz found among several hundred soldiers of the Austrian army 61 to 68 per cent reacting to comparatively small doses of tuberculin (1 to 3 mgm.), and he believes that with the higher doses he would have reached the 96 per cent of Nägeli's autopsy series. Von Pirquet also found that practically all adults react to the cutaneous tuberculin test, thereby, as he believes, proving that almost everybody at one time or another has been infected with tuberculosis.

Of particular interest are von Pirquet's ('09) tuberculin findings in childhood. They are best illustrated in the accompanying graphic charts. In Figure 16 all cases (1,407) are shown, with the exception of those suffering from measles, in which the cutaneous test is always negative. The shading denotes all reacting cases. From 5 per cent in the first year the percentage of reacting cases increases rapidly, until it reaches 80 per cent in the tenth and eleventh years. The percentages of those cases, however, which showed evident clinical signs of tuberculosis (marked by black bars) are distinctly below those with positive tuberculin reaction. But it is also clear that the earlier the age the more often patients reacting to the test also have signs of manifest tuberculosis. Latent tuberculosis, therefore, increases with succeeding years.

In Figure 17 all the manifest and suspected cases of tuberculosis (also bronchitis, anemia) are omitted, leaving 1,134 children. In the first two years there is no shading, indicating that at that age, if tuberculous infection occurs at all, it produces always some clinical symptoms bronchitis or anemia. Latent tuberculosis revealed by the

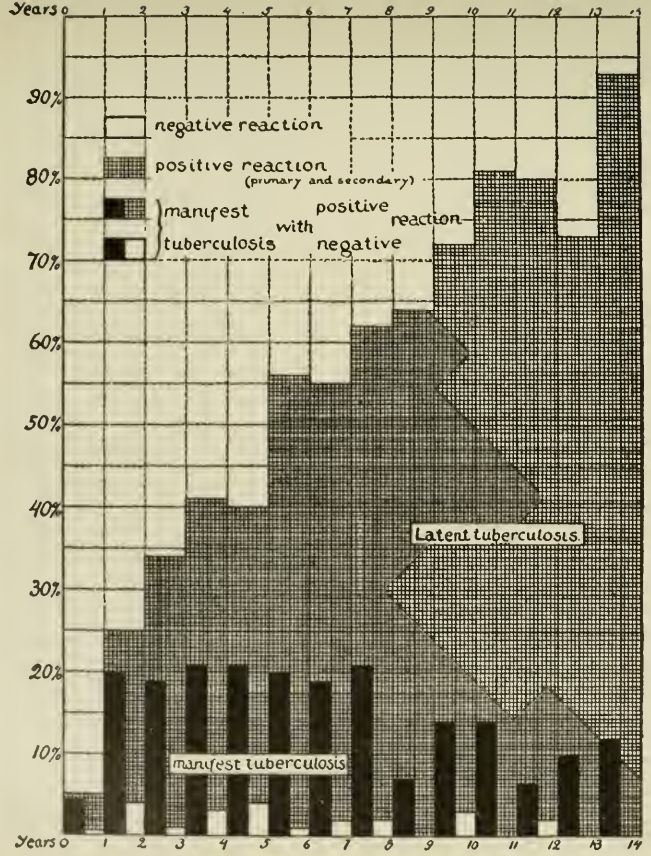

FIG. 16.—CUTANEOUS TUBERCULIN REACTION IN 1,407 CHILDREN. (Von Pirquet, Escherich Clinic, Vienna. From *J. Am. Med. Ass.*, 1909.)

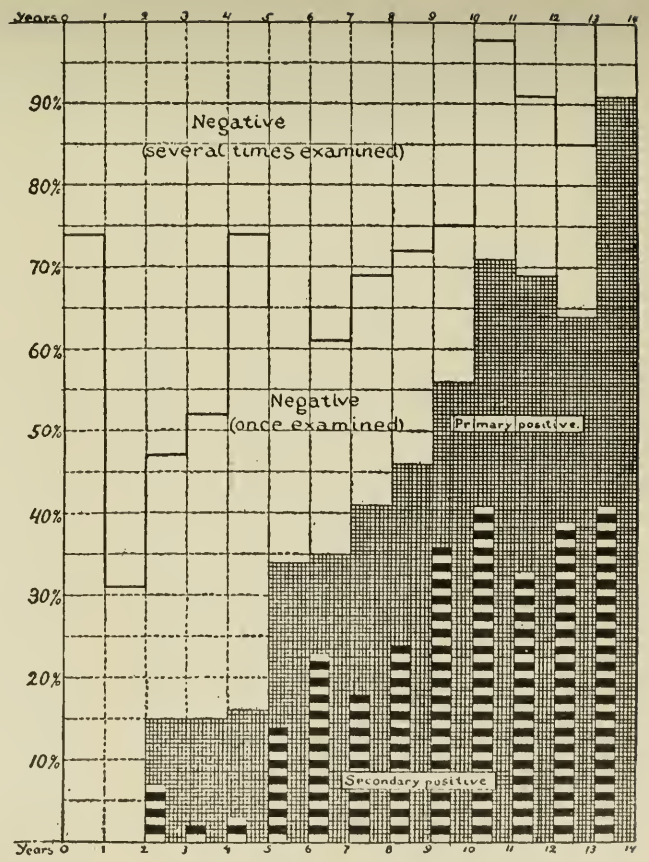

FIG. 17.—CUTANEOUS TUBERCULIN REACTION IN 1,134 CLINICALLY NONTUBERCULOUS CHILDREN. (Von Pirquet, Escherich Clinic, Vienna. From *J. Am. Med. Ass.*, 1909.)

tuberculin test, on the other hand, reaches in similar manner as before 70 per cent in the tenth year.[1]

It is notable how closely von Pirquet's results correspond with the percentages found by Hamburger and others in autopsies. The subject will of course need further investigation, but these findings of early tuberculous infections are extremely suggestive, especially as regards the phthisiogenesis in later life.

It will be remembered that von Behring, in his Kassel address ('03), laid the greatest stress on the occurrence of infection in early childhood for the production later of pulmonary phthisis. Andvord ('08) believes that only 20 to 30 per cent of the lethal cases can be ascribed to acute infections of short duration, while the balance was acquired primarily during childhood. The time between tuberculous infection and death is therefore of very variable length.

"TUBERCULOSIS A CHILDREN'S DISEASE"

The view that tuberculosis is eminently a children's disease, something like measles, producing fatal results at once in early childhood or an increased resistance against evil influences in later years, wins more and more adherents during the last years. The excellent work of Harbitz ('05), demonstrating the great frequency of latent glandular tuberculosis in childhood, has probably first drawn more general attention to these important facts. This great frequency of latent tuberculosis in childhood need not cause grave apprehensions, as expressed by Schlossmann ('08). The tuberculous infection, even if it remains perfectly latent, produces a certain degree of immunity against a secondary tuberculosis (Hamburger, '09). Under certain not yet clearly defined conditions a soil can be prepared for pulmonary phthisis. These exceedingly interesting considerations are as yet largely speculative. Their full meaning is discussed elsewhere in this work in greater detail (von Pirquet, Tuberculosis in Children).

MORBIDITY STATISTICS

There are no reliable figures which can give anything but a very approximate idea only of the amount of sickness produced by tuberculosis in a given population. The formula, number of deaths from tuberculosis multiplied by three, is usually employed for such an estimate. The result is entirely meaningless, and exploited mostly to im-

[1] In this chart a distinction is also made between primary and secondary reactions, according to whether the children reacted to the first test or the second test only. Von Pirquet notes it as a common occurrence that especially older children react only after some days ("torpid reaction") or only to a second test.

press the public with the magnitude of the problem. The insidious onset of the disease and its eminent chronicity protect it from discovery. It often disables its victim for months and even years before its true nature is recognized. Even a rigidly enforced system of registration can never furnish a basis for accurate estimation of the damage done by the disease. The nearest approach to it can be found in the statistics of standing armies, although the figures must necessarily be much smaller than in total population, being derived from a corps of men scrutinized carefully as regards their physical fitness.

For 1,000 of active troops in the various armies of the Powers, the following figures for cases of pulmonary tuberculosis are obtained: United States ('06), 4.72; Great Britain and colonies ('06), 2.4; France ('04), 5.3; Germany ('03–'04), 1.5; Austria ('06), 1.0; Russia ('04), 2.7.

MORTALITY STATISTICS AND THE DECREASE OF TUBERCULOSIS

If mortality statistics are analyzed even with such precautions as have been alluded to, it must still be remembered that absolute figures are meaningless, and that total numbers of deaths without a statement of their distribution in the various age periods conveys no valuable and purposeful idea about the frequency of the disease.

The age distribution of tuberculosis mortality in the United States is shown in the accompanying table and Figure 18. These figures of the

Age.	Consumption.	
	1900.	1890
Under 1 year	18.3	18.3
1 "	9.4	10.3
2 years	5	5
3 "	3.6	3.1
4 "	2.2	2.4
5–9 years	10.6	9.9
10–14 "	17.1	18.9
15–19 "	70.6	78.7
20–24 "	136.7	142.2
25–29 "	153.7	149.0
30–34 "	132.7	124.7
35–39 "	113.6	102.5
40–44 "	82.0	78.8
45–49 "	67.0	65.4
50–54 "	50.0	50.4
55–59 "	39.5	40.1
60–64 "	31.4	34.7
65–69 "	25.8	27.8
70–74 "	17.5	17.7
75–79 "	11.2	11.9
80–84 "	4.4	5.2
85–89 "	1.6	2.0
90–94 "	0.3	0.4
95 and up	0.1	0.2

two last censuses show the tremendous mortality at the ages between twenty and forty years, the active working period. Of interest is the comparison of the sets of figures for the two census years which indicate

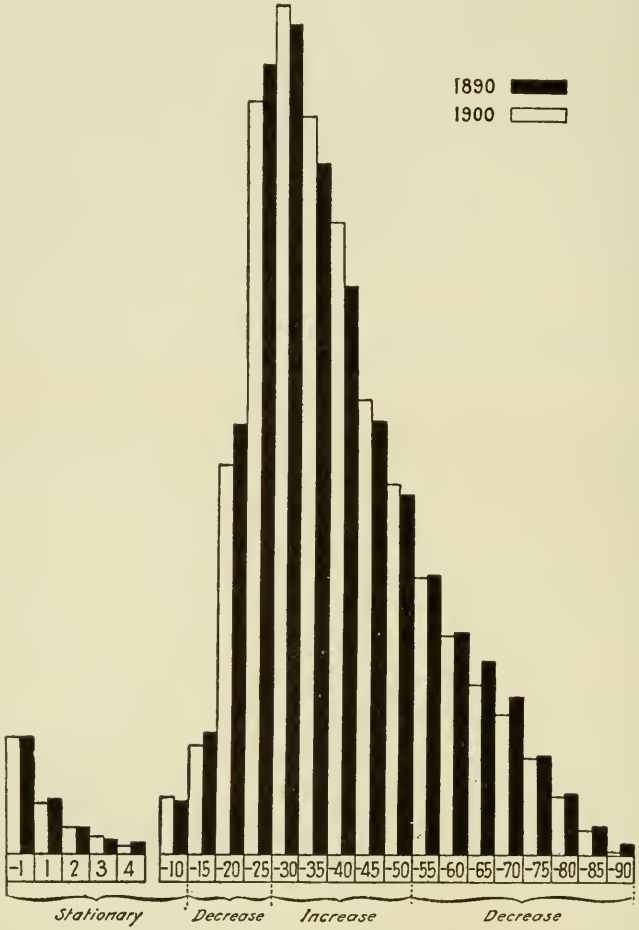

FIG. 18.—THE AGE DISTRIBUTION OF CONSUMPTION MORTALITY. Proportions of deaths at each age per 1,000 at known ages from consumption 1890 to 1900. (12th U. S. Census Reports, vol. iii, 1902, p. 179.)

an increase of tuberculosis during the age periods of from twenty-five to fifty years of age, while at other periods it has either decreased or remained stationary.

If one compares the figures of death from tuberculosis to the total population at given ages, as has been done in Figure 19, the age distribution of tuberculosis assumes a somewhat different aspect, correspond-

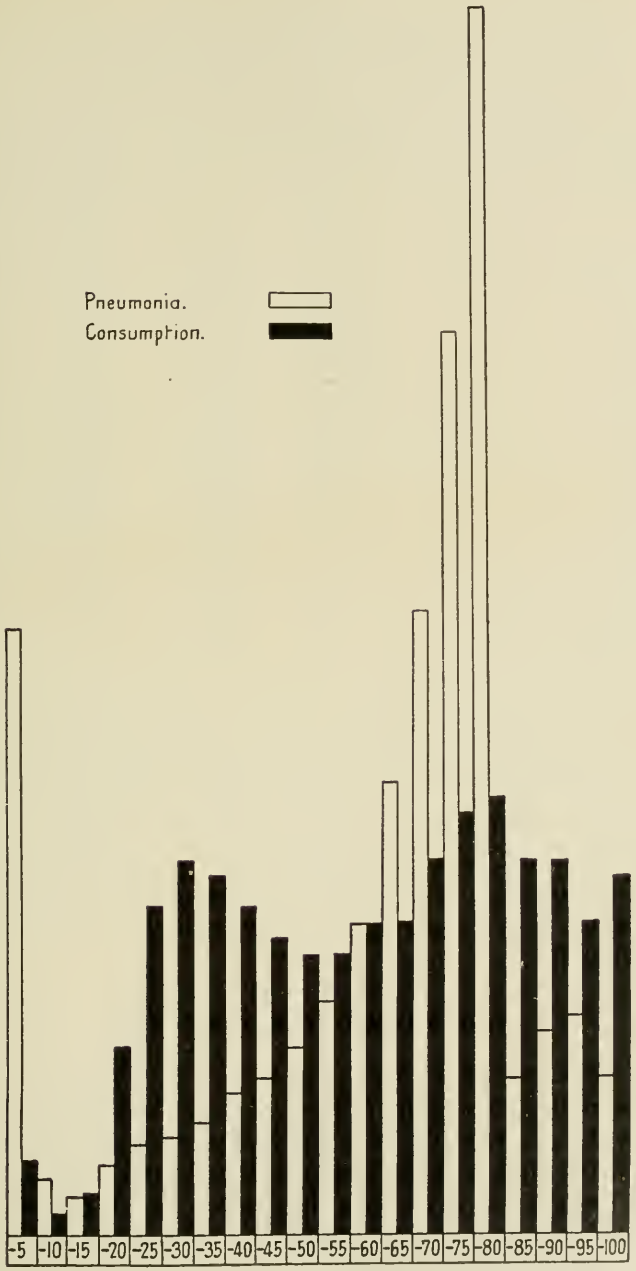

FIG. 19.—PROPORTIONS OF DEATHS FROM PNEUMONIA AND CONSUMPTION AT CERTAIN AGES TO 1,000 LIVING AT THOSE AGES. (12th U. S. Census Reports, vol. i and iv.)

Age.	Consumption.		Pneumonia.	
	Total number of deaths.	Per 1,000 living.	Total number of deaths.	Per 1,000 living.
Under 1 year	2,011		19,662	
1 "	1,168		9,796	
2 years	622		4,349	
3 "	375		2,189	
4 "	278		1,310	
5 "	4,454	0.47	37,206	3.90
5–9 years	1,287	0.14	3,322	0.37
10–14 "	2,210	0.27	2,042	0.25
15–19 "	9,104	1.20	3,474	0.45
20–24 "	16,031	2.10	4,326	0.58
25–29 "	15,811	2.40	4,077	0.62
30–34 "	12,805	2.30	4,065	0.73
35–39 "	10,833	2.10	4,532	0.91
40–44 "	8,376	1.90	4,431	1.04
45–49 "	6,456	1.80	4,400	1.20
50–54 "	5,465	1.80	4,700	1.50
55–59 "	4,424	2.00	4,566	2.06
60–64 "	3,652	2.03	5,198	2.90
65–69 "	3,193	2.40	5,325	4.08
70–74 "	2,396	2.70	5,156	5.80
75–79 "	1,459	2.80	4,170	8.02
80–84 "	615	2.40	2,725	1.08
85–89 "	214	2.40	1,229	1.30
90–94 "	49	2.04	336	1.40
95 and over	23	2.30	115	1.17

ing to the lesser number of people living at the more advanced age periods. The comparison with the mortality from pneumonia brings out the significant fact that this latter disease is fatal particularly at the two extremes of life, while tuberculosis overwhelmingly affects the whole adult life period. By virtue of this fact as well as by its great disabling power, not for a short period as in the case of pneumonia but for long months and years, tuberculosis constitutes the grave social problem which is now engaging the whole civilized world in a common effort against it.

GEOGRAPHIC DISTRIBUTION

Here, again, our knowledge is based more on impression than on a calculation resting on accurate figures. It would lead entirely too far to enter into the details of the laborious studies of the subject in various districts of the earth made by Lombard, Hirsch, and others. The chief fact they brought out is the even distribution of tuberculosis in civilized lands very little influenced by climatic differences. The causes for this must be looked for in certain features of civilized life itself. The attempt made to assign to some particular defects in civilized society the chief responsibility for the prevalence of tuberculosis must be re-

garded as futile, as a great complexity of conditions exists in different countries. From the foregoing it has been seen that the fact of infection itself (of "exposition," as termed by the strict contagionists) plays probably a lesser rôle in the varying production of tuberculosis in different age periods, individuals, and races, but that the individual resistance to the more or less unavoidable infection is the determining factor. The last shot has not yet been fired in this battle of opposing theories.

CHAPTER II

TUBERCULOSIS AMONG THE DARK-SKINNED RACES OF AMERICA

By THOMAS D. COLEMAN

Medical history teaches that there are exciting and predisposing factors at work in the production of disease; that certain races are especially subject to some diseases, while they are markedly resistant to others. Two concrete examples are sufficient. The negro under his present environment is subject to tuberculosis and syphilis; he is resistant to malaria and yellow fever. The Jew is susceptible to cancer and diabetes; he is resistant to tuberculosis and syphilis.

Additional evidence is furnished by the animal kingdom of susceptibility and immunity. According to Roger, Algerian sheep are refractory to anthrax and the black sheep of Bretagne are immune to murr. Animals of the same species possess varying degrees of immunity, according to their environment—e. g., white rats fall a ready prey to anthrax, while gray rats are to a large extent immune. To the monkey in his jungle life tuberculosis is unknown; in captivity it destroys more of the species than all other diseases combined. Cattle in Japan have been singularly free from tuberculosis; in this country and Europe it is much too prevalent, causing enormous financial loss and, in the light of our present knowledge, is a prolific source of infection in man.

Tuberculosis was almost unknown to the negro in his savage state, and even in his condition of slavery in this country; whereas under his changed condition of freedom, broadly speaking, it carries off three to four of this race to one of the Caucasian. The North American Indian furnishes still further evidence in this direction. Before the invasion of the white man and the attendant civilized modes of life to which he introduced this son of the forest, tuberculosis was unknown among the Indians; now it is a frequent invader and destroyer of his race. A similar condition of affairs is noted in the other dark-skinned races, and even the light-skinned races which are newly subjected to the infection. These are matters of fact, and an adequate explanation of them can only be found by appeal to the theory of immunity. Modern pathology is

based on the theory that pathogenic organisms lose their virulence in healthy serum. Immunity is probably not absolute in any disease except syphilis; however, it is relatively so in such diseases as variola, varicella, scarlatina, measles, pertussis, yellow fever, etc.

Immunity is transient or evanescent in diphtheria, pneumonia, influenza, malarial fever, etc. Immunity may be inherited or acquired; it is in these two latter phases of the subject that we find a working hypothesis to explain why tuberculosis is rare or infrequent in some races and yet decimates others. In the Jewish race it is difficult to explain the relative infrequence of tuberculosis except on two theories: first, an immunity acquired throughout an eventful history of more than forty centuries, and second, through the careful meat inspection which is still practiced by the orthodox Jews. The former is the more logical explanation.

It is now thought by many that a relative immunity may be transmitted from parent to child; then why not from generation to generation? On this theory only can we explain why whole families are not destroyed, instead of one or two members, by tuberculosis, when it occurs in one or both parents. Additional arguments may be obtained from other infectious diseases. Small-pox, when introduced among a new people in Iceland in 1707, caused the death of 18,000 out of a total population of 50,000. In Mexico and other newly exposed countries a similar sequence of events happened. Now, through ages of infection and vaccination, it is a milder disease, is comparatively rare, and a readily controllable infection; so much so that its spread to any material extent is a reflection on the health authorities of any community.

Syphilis is believed by some to have been introduced into the Old World from the New. Whatever may be the merits of this question from an historic standpoint, it is true that it first attracted widespread attention in 1494, when the troops of Charles VII of France were fighting in the expedition against Naples. It spreads with alarming rapidity among new peoples.

Measles appeared for the first time in the Faroe Islands in 1846. Of 7,782 inhabitants, 6,000 were attacked.

In 1875 in the Fiji Islands, 40,000 out of a population of 150,000 died from measles. No such invasion occurs among races that have been exposed to this disease throughout centuries, or even years.

Roger states that predisposition and immunity exists in varying degrees in peoples of the same race, in families, and that there are numerous individual variations. These are usually called idiosyncrasies, a good example being those individuals in whom vaccination fails. In the absence of a better explanation, and from a survey of clinical experience, both past and present, we cannot but conclude that there is at

present, and doubtless always will be, a racial immunity and susceptibility.

By this we do not mean to imply that the immunity or susceptibility of any race to any specific disease is perpetual or will continue indefinitely; on the contrary, it is likely that these conditions will undergo change with time and environment. It is possible, therefore, that succeeding generations of these dark-skinned races will develop a constantly decreasing predisposition to tuberculosis, and they may develop a degree of immunity to it that is now enjoyed only by the Jews. Until such time we are brought face to face with the problem of a special susceptibility in these dark-skinned races.

Admitting, then, that these peoples are at present more susceptible to tuberculosis than are the whites, it is interesting to inquire into the causes which account for this particular susceptibility. The writer has chosen to call this susceptibility racial, not because these peoples have black or red or brown or yellow skins, and therefore their opsonic index is low or high, but because these races are for the most part recently introduced to civilization and infection. The negro, the Indian, and the Eskimo have but comparatively recently passed from an uncivilized to a civilized existence, and the Eskimo in many instances still holds to his semisavage life, living in thinly populated districts and arctic regions. The same influences which have kept tuberculosis from being a scourge to cattle in Japan have doubtless operated to make the disease less frequent among the Chinese and Japanese at home; it is simply a matter of exposure, or the lack of it.

The civilization of these people antedates that of many of the white races, but they are not protected by that degree of immunity which has come to the latter through centuries of exposure; consequently, when this raw material comes to us and adopts our lower—not higher—hygienic modes of living, tuberculosis makes rapid and fatal inroads among them. This point finds additional proof in the Irish. The Emerald Isle is venerated by the Irish as is Jerusalem by the Jew and Mecca by the Mohammedan; outside of Dublin, Cork, and a few other large cities the Irish follow largely a bucolic existence. When they migrate to this country for some reason they settle in densely populated cities, and make a radical change in their methods of existence. Instead of becoming farmers, as they were in their own country, they throng the cities, becoming politicians, liquor dealers, clerks, etc. Many of them yield to the temptations and dissipations of urban life. Few of them take to farming, and as a result statistics show the Irish to be more vulnerable to tuberculosis than any other white race. Here again, dissipation, environment, and a new people account for the prolific harvest.

TUBERCULOSIS IN THE NEGRO

After having studied this problem for nearly two decades and having known the habits and vices of the negro for a lifetime, the writer has often wondered that the disease is not more prevalent among them. As a class they are shiftless, accepting literally the biblical injunction, "Take no thought of the morrow." Necessity with them is not the mother of invention, but the one and only incentive to work. In studying the evolution of the race it is interesting to note this phase of its character. In their condition of bondage they were still in large measure Nature's children, living for the most part in the open and tilling the soil. They were well housed, well clothed, well fed, and when sick were attended by a competent physician, for, irrespective of any motives of humanity, it was to the financial interest of the planter to have his slaves receive as good medical advice as could be obtained. Except for the yoke of bondage they were care-free and had all their material wants supplied.

After their emancipation they required for their maintenance forty to fifty cents per working day. Heads of families and farm hands received before emancipation $8 to $10 per month, and their rations consisted of one peck of meal, four pounds of bacon, and a quart of sirup per week. Usually a cabin was furnished them, and around this they cultivated vegetables such as they needed, consisting mainly of cabbages, collards, etc. On this dietary and under these surroundings they waxed strong and remained free from tuberculosis, but they had to work more or less continuously. Freedom, the march of civilization, the additional demand for labor, and politics, have made them forsake the plantation for the town. Instead of being care-free, they have been forced to care for themselves; instead of physical work for which they are at this time fitted, their brains are being filled with Latin and Greek and other accomplishments of a higher order, for which they are not fitted; restraint is withdrawn from them, and they run riot in dissipation and vice; they reach for the enjoyments of a higher civilization without proper preparation or equipment, either mental or moral.

Instead of the farm hand receiving $8 to $10 per month and his keep, he receives $10 to $20; instead of the city laborer receiving seventy-five cents per day, he receives $1 to $2.50 per day. The result is inevitable—the farm hands drift to the city, where they live under most unhygienic surroundings. Instead of having to work twenty-four or twenty-six days per month to obtain a livelihood, this can be gotten in half the time with their increased wages, and the rest of the time is given over to idleness and dissipation. The race is undergoing an evolutionary stage at present which for the most part leads in the direction

of their improvement, but those philanthropists who think to benefit them by teaching them Latin and Greek and the Romance languages, are working a double injury instead of a blessing, for it produces a hybrid which, like the mule, has no "pride of ancestry nor hope of posterity." It gives the negro a false idea of his position, and henceforth he will do no more physical work. It robs the country of a type of labor that might be beneficial both to it and to the laborer, and aside from this emphasizes the difficulties of the race problem.

The average negro is ignorant of the fundamental laws of hygiene, and the following picture may be multiplied throughout the South not by thousands but by hundreds of thousands of times:

A negro, once a hostler, went to New York and became a waiter. He had returned home to die of tuberculosis. He and his family lived in two rooms and a kitchen; the front room was used as a parlor; the back room, in which the family slept and which was perhaps 15×15 feet, was lighted by one window and a door which looked to the west and caught the last rays of the setting sun when they were left open, which was infrequent; the other opening to the room led into the parlor. The bed clothing was doubtless changed, but never to the writer's knowledge. A common towel served the family, as did also a tin basin; flies literally swarmed in the room and were crawling over the patient's face and the tomato can, which was used as a cuspidor, when the patient was inclined to use it instead of the floor. The air in the apartment was heavy and noisome. A brother of this man, who slept in this house, was a coachman. It is needless to state that several of this generation died of tuberculosis. The others have been lost sight of.

This presents a picture which, so far from being an exaggeration, is above the average of what one finds in studying this race. Negroes are given over to dissipation; sexual excesses and venereal diseases exist among them to an extent scarcely to be comprehended by one who has not lived among them. It is claimed that from fifty to seventy-five per cent of the negro population has syphilis, either hereditary or acquired. While statistics on this point are lacking, this opinion is verified by every Southern practitioner. Whisky and other alcoholic drinks prove irresistible temptations. Nervous diseases and insanity are increasing among negroes with terrific strides. In Georgia, before the Civil War, there were known to be only five insane negroes; now the State lunatic asylum contains more than a thousand, and hospitals, jails, and poorhouses and many homes are burdened with them.

There are two other phases of the tuberculosis problem that stand out prominently in the negro. The first is this: When the negro de-

velops tuberculosis it rarely leaves its victim alive; in other words, the mortality is much greater than among the whites. The second pertains to tuberculosis among the mulattoes; in these it seems to be more fatal than in the full-blood negroes. The medical profession of the South is unanimous in the opinion that in the negro's condition of slavery tuberculosis was comparatively unknown. These facts, which are chiefly medical and partly sociologic, will explain the excessive death-rate from tuberculosis in this race. They will also be suggestive to philanthropists who wish to benefit the negro and physicians in the South who must assume the duty of treating and caring for them; for aside from that duty which falls to the lot of every physician to heal the sick, whether poor or rich, there comes the additional call to protect the innocent. While tuberculosis exists as such a scourge among the negroes, it is plain that the white population is benefited when the disease is checked in the negro, for these people serve in the households of the whites as nurses, washerwomen, cooks, chambermaids, etc.

The statistics from cities in both the North and the South cannot but carry their lessons, and the philanthropists who really wish to elevate the race will do better to devote their money to the erection of hospitals and dispensaries and instructing these people in trades, rather than to the erection and maintenance of colleges for the exploiting of higher mathematics, sciences, and the dead languages, for which the present status of the race finds little or no preparation. The writer does not wish to be understood as decrying or disparaging the progress of the negro. What he has said concerning him applies with even greater force to the Indian, and with less excuse. The negro, transplanted from his African home, enslaved, and finally freed, has become a producer; from this point of view slavery was therefore to the negro a blessing in disguise; the Indian, on the other hand, although given or allowed to retain lands, fed and pampered by a sentimental government, is a parasite. The comparison is all in favor of the negro, but the medical and sociological facts concerning both races remain undisturbed. Since the tendency of the negro is toward the congested districts, the statistics concerning him are fuller and more reliable than for any other of the dark-skinned races except the Indian, who, like a Government note, must be accounted for by the Government, but who, for manifest reasons, is not so available for comparison as the negro (see Fig. 20).

Thomas J. Jones ('06) makes the following observations to this chart:

In the cities of the South with a negro population ranging from twenty-seven per cent in New Orleans to fifty-six per cent in Charleston, S. C., the death-rate of the negroes from consumption is two and three times that of the whites. Though the proportion of negroes in Northern cities is small, the actual number is quite large. New York and Philadelphia, each with over sixty thousand negroes, have a very high death-

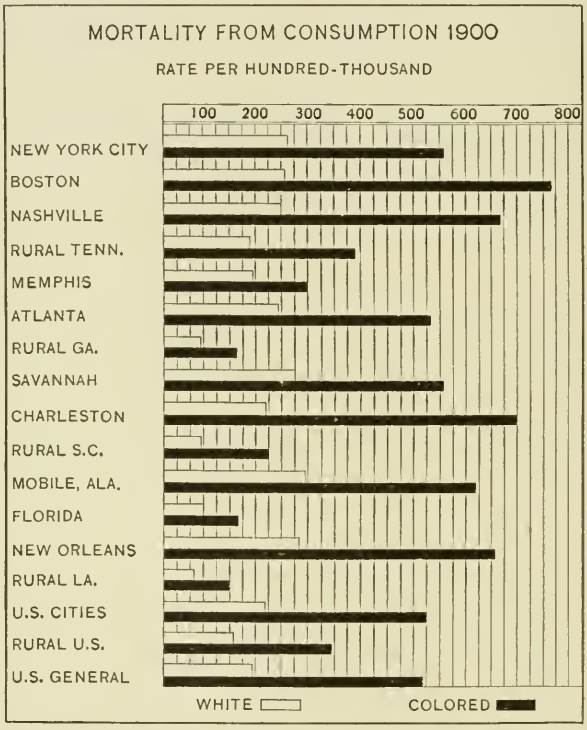

Fig. 20.—Comparative Mortality from Consumption of Whites and Blacks in Cities and Districts of the United States. (Thomas J. Jones.)

rate from tuberculosis. Boston, with a negro population of about twelve thousand, has the highest rate of negro mortality from consumption of any city in the United States. According to the census of 1900 for the District of Columbia, the mortality of the 87,000 colored people from consumption was 448, while that for the 172,000 whites was 403. Thus a little over half of the total number of deaths is credited to a third of the people. If, as was stated in Charities for May 12th, there is one consumptive to every one hundred Washingtonians, it follows that there

are one colored and one white consumptive to every two hundred Washingtonians.

In Charleston, S. C., Augusta and Atlanta, Ga., and New Orleans, La., typical cities of the South, the mortuary tables for tuberculosis for whites and colored are as follows:

CHARLESTON, S. C.

YEAR.	DEATHS FROM TUBERCULOSIS.		TOTAL DEATHS.		POPULATION.	
	White.	Colored.	White.	Colored.	White.	Colored.
1898	47	221	491	1,258	28,870	36,295
1899	42	223	526	1,277	28,870	36,295
1900	40	194	484	1,242	24,285	31,522
1901	46	159	477	1,149	24,285	31,522
1902	36	181	461	1,154	24,285	31,522
1903	53	165	426	1,041	24,285	31,522
1904	44	162	455	1,089	24,238	31,569
1905	36	167	440	1,056	24,238	31,569
1906	33	159	442	1,102	24,285	31,522
1907	24	152	433	968	27,470	29,899

YEAR.		White.	Colored.
1898	Ratio of deaths from tuberculosis to total mortality	1–10.44	1–5.69
1899	" " " " " " " "	1–12.61	1–5.72
1900	" " " " " " " "	1–12.10	1–6.40
1901	" " " " " " " "	1–10.37	1–7.22
1902	" " " " " " " "	1–12.80	1–6.37
1903	" " " " " " " "	1– 8.30	1–6.30
1904	" " " " " " " "	1–10.34	1–6.78
1905	" " " " " " " "	1–12.22	1–6.32
1906	" " " " " " " "	1–13.39	1–6.93
1907	" " " " " " " "	1–18.04	1–6.39

AUGUSTA, GA.

YEAR.	DEATHS FROM TUBERCULOSIS.		TOTAL DEATHS.		POPULATION.	
	White.	Colored.	White.	Colored.	White.	Colored.
1898	19	87	293	509	30,435	19,565
1899	31	94	366	530	30,435	19,565
1900	45	95	343	612	30,435	19,565
1901	28	112	317	600	22,876	16,565
1902	24	60	351	556	24,865	16,576
1903	23	75	291	473	24,465	16,916
1904	35	70	340	522	26,065	17,316
1905	34	59	330	444	26,665	17,716
1906	37	62	371	503	28,000	19,200
1907	39	64	386	449	29,520	19,680

AUGUSTA, GA., *Continued*

YEAR.		WHITE.	COLORED.
1898	Ratio of deaths from tuberculosis to total mortality	1–15.27	1–5.83
1899	" " " " " " " "	1–11.80	1–5.82
1900	" " " " " " " "	1– 7.62	1–6.44
1901	" " " " " " " "	1–11.32	1–5.32
1902	" " " " " " " "	1–14.66	1–9.26
1903	" " " " " " " "	1–12.65	1–6.30
1904	" " " " " " " "	1– 9.71	1–7.45
1905	" " " " " " " "	1– 9.70	1–7.52
1906	" " " " " " " "	1–10.02	1–8.11
1907	" " " " " " " "	1– 9.89	1–6.85

In other words, though the colored population is ten per cent to sixteen per cent less than the white, in ten years tuberculosis carried off 778 white persons and 315 colored. In round numbers, allowing for the discrepancy in population, about twice as many colored people die annually from tuberculosis as in the white race.

ATLANTA, GA.

YEAR.	DEATHS FROM TUBERCULOSIS.		TOTAL DEATHS.		POPULATION.	
	WHITE.	COLORED.	WHITE.	COLORED.	WHITE.	COLORED.
1899	97	148	1,045	1,197	75,000	50,000
1900	80	134	916	1,014	79,000	52,000
1901	87	135	914	1,227	82,000	53,000
1902	110	153	979	1,092	60,000	40,000
1903	88	133	926	1,015	66,000	44,000
1904	115	165	1,053	1,253	72,000	48,000
1905	108	171	1,128	1,206	75,000	50,000
1906	111	161	1,182	1,299	80,000	55,000
1907	114	114	1,275	1,258	85,000	55,000

YEAR.		WHITE.	COLORED.
1899	Ratio of deaths from tuberculosis to total mortality. Same ratio of whites would give death-rate 222.	1–10.77	1– 8.08
1900	Ratio of deaths from tuberculosis to total mortality. Same ratio would give white mortality 203.	1–11.45	1– 7.56
1901	Ratio of deaths from tuberculosis to total mortality. Same ratio would give white mortality 208.	1–10.50	1– 9.06
1902	Ratio of deaths from tuberculosis to total mortality. Same ratio of whites would give death-rate 229.	1– 8.09	1– 7.15
1903	Ratio of deaths from tuberculosis to total mortality. Same ratio of whites would give death-rate 201.	1–10.52	1– 7.63
1904	Ratio of deaths from tuberculosis to total mortality. Same ratio of whites would give death-rate 247.	1– 9.15	1– 7.59
1905	Ratio of deaths from tuberculosis to total mortality. Same ratio of whites would give death-rate 256.	1–10.44	1– 7.05
1906	Ratio of deaths from tuberculosis to total mortality. Same ratio of whites would give death-rate 234.	1–10.64	1– 8.44
1907	Ratio of deaths from tuberculosis to total mortality. Same ratio of whites would give death-rate 176.	1–11.19	1–11.03

New Orleans, La.

Year.	Deaths from Tuberculosis.		Total Deaths.		Population.	
	White.	Colored.	White.	Colored.	White.	Colored.
1897	405	454	4,268	4,462	195,000	80,000
1898	546	447	4,275	2,551	195,000	80,000
1899	544	490	4,913	2,980	210,000	90,000
1900	512	500	4,318	3,106	210,000	90,000
1901	483	452	4,037	2,441	210,000	90,000
1902	549	494	4,067	2,505	227,000	83,000
1903	549	504	4,200	2,505	233,000	84,000
1904	578	564	4,222	2,597	239,000	86,000
1905	540	543	4,689	2,640	245,000	88,000
1906	499	483	4,150	2,668	251,000	90,000
1907	575	480	4,665	2,968	258,000	93,000

Cases of hemoptysis included. Pneumonic tuberculosis included.

Year.		White.	Colored.
1897	Ratio of deaths from tuberculosis to total mortality	1–10.53	1–9.82
1898	" " " " " " " "	1– 7.82	1–5.70
1899	" " " " " " " "	1– 9.03	1–6.08
1900	" " " " " " " "	1– 8.43	1–6.21
1901	" " " " " " " "	1– 8.35	1–5.40
1902	" " " " " " " "	1– 7.22	1–5.07
1903	" " " " " " " "	1– 7.46	1–4.95
1904	" " " " " " " "	1– 7.47	1–4.60
1905	" " " " " " " "	1– 8.68	1–4.86
1906	" " " " " " " "	1– 8.31	1–5.85
1907	" " " " " " " "	1– 8.11	1–6.18

TUBERCULOSIS IN THE INDIAN

It is generally conceded that pulmonary tuberculosis was not known to the Indian in his barbaric state—at least, that it was a disease of rare occurrence. The Indian is of a race of people over whom our Government has felt it needful to keep an accurate supervision. The physicians who have cared for them have, for the most part, been selected. Their positions have demanded that they make an accurate report of their stewardship. The reports, therefore, of the sanitary condition of this race are more perfect than for any race in America. For the Indians, then, they may be accepted as approximately accurate. There has been an impression both among the laity and the medical profession that tuberculosis is a scourge of this race since its contact with the white man, and an inquiry into its history is essential to fix the accuracy of this conclusion.

Dr. James R. Walker ('06), of Pine Ridge, South Dakota, states that:

Tuberculosis existed among these Indians before they came into contact with the white people, but at that time the disease was rare among them and remained so until they changed their nomadic to a settled life in houses. When they began to live in houses, tuberculosis began to increase among them, so that the conditions which caused this increase must have been different from those surrounding them when they lived in tepees. They were filthy both when they lived in tepees and when they lived in houses. It was statistically demonstrated that those who were most cleanly were less liable to infection by any disease than were the most filthy; and, conversely, that the most filthy were most liable to infection of every kind.

In 1896 it was asserted that more than one half of the Oglalas were tuberculous, and that more than seventy-five per cent of the total deaths among them were caused by this disease. This was an exaggeration that is common in discussing tuberculosis among the Indians. The facts were that there were at that time 4,893 Oglalas, of whom 741 were tuberculous, and of these 124 died that year. That is, 148.7 per 1,000 were tuberculous, and the annual death-rate from this disease was 24.88 per 1,000. As the entire annual death-rate was 52.88 per 1,000, the deaths from tuberculosis were but forty-seven per cent of this.

But this death-rate was appalling, for the annual birth-rate was but 41.54 per 1,000, which showed a decrease of 11.64 per 1,000 because of the excess of the death-rate over the birth-rate. As the percentage of deaths from tuberculosis was so great, this disease was exterminating this people.

Dr. I. W. Brewer, of Fort Chihuahua, Ariz., has made a careful study of the Indians of the Southwest. Woods Hutchinson ('07) sums up his findings as follows:

Among the Mojaves tuberculosis was responsible for ninety-five per cent of the deaths. Among the Hopis and Navajos it was, according to one agency physician, "very prevalent," and according to another, Dr. Parshell, "the greatest cause of death in children." On another Navajo reservation it was reported as "not very prevalent, but always fatal." Among the Apaches it had "gained a strong hold." Among the Pimas and the Maricopas it caused sixty-six per cent of the deaths. Among the Havasupi and Walapai it caused seventy-five per cent of the deaths; on another, sixty per cent. Among the Pueblo Indians at Santa Fé it was "rare, less frequent than with other Indians." Among the Zunis the actual amount was small, "but the mortality one hundred per cent." The average, from the percentages actually given in these cases, was seventy-two per cent of all the deaths. This, with my Northern studies, pretty well covered the Indians of the Pacific Northwest and of the Coast and most of the great Southwest.

At the Black Feet agency Dr. George Martin reports that "sixty-seven per cent of the deaths were due to that disease in that year."

From the Crow Creek agency, in South Dakota, Dr. J. Silverstein reports that "most of the deaths are due to this cause."

Among the Rosebud Sioux Dr. W. H. Harrison declares it to be "the greatest menace to the health of the tribe." (Hutchinson, '07.)

To Sum up.—On nine reservations where the actual figures are given, the average proportion of deaths due to this disease is sixty-six per cent. When one attempts to explain this enormous death-rate he is confronted with much the same conditions as the negro presents, only in a more exaggerated form. The inclination of the Indian to dissipation and his disinclination to work, his filthy habits, his ignorance and utter disregard of the laws of hygiene, and finally his lack of immunity and racial predisposition—all account for the enormous death-rate among them from tuberculosis.

TUBERCULOSIS AMONG THE JAPANESE AND CHINESE

Statistics are often misleading when accurately kept. When inaccurately kept they are worthless. With medicine occupying the place it has in Japan and China throughout all recorded history, it is clear that little can be expected from a statistical study of this disease in these countries. It is a matter of common observation that Chinese and Japanese who come to this country are especially liable to contract tuberculosis, and such statistics as are recorded show a relatively high mortality for these races as compared with our native white populations. The United States Census for 1900 gives the death-rate of 239 per 100,000 living Japanese, as compared with 173 in the white population. Hutchinson states that "in the Portland and San Francisco Chinatowns the mortality was more than double that of the surrounding white population," and the United States Census for 1900 gives 658.5 per 100,000 living, nearly four times that of the general white population.

The cause for this appalling death-rate will be readily apparent, particularly in the case of the Chinese. To begin with, we have brought to our shores a new and relatively susceptible race of people. They are densely ignorant and utterly disregardful of the fundamental laws of hygiene. They represent the lowest grade of citizenship in their own densely benighted land. Their intelligence is sufficient to make them hold to two purposes, viz., the preservation of the cue, which is the "open sesame" to the Chinese Empire, and the accumulation of sufficient money to live out their remaining days in China without further work when they return home.

Neither the preservation of the cue nor the accumulation of wealth are ignoble, nor do they concern us, beyond the inroads which the acquisition of the latter make on the races. The average Chinaman coming to this country was of the coolie class, therefore too much should not be expected of him, but his menace to his immediate neighbors does concern us. The writer believes that they are in this country cleanly of body and careful of what they eat; they are also industrious, probably beyond reason. This is unquestionably to their credit, and if that were all, these people would make a desirable instead of an undesirable citizenship. When one passes to the other phases of their character he does not wonder at the amount of tuberculosis that is prevalent among them.

Notoriously and ahead of all the other dark-skinned races is the Chinaman given over to dissipation and vice. He cares nothing for the comforts or restraints of the home. Gambling is his pastime; he inclines to sexual excess; as a race he is addicted to the opium habit, and to this in America he often adds alcohol; finally, where their least discretion is shown is in their sleeping apartments. Ventilation is a thing unknown to them, and a not unusual sleeping apartment in the Chinatowns of this country is four by eight feet. Usually there is a gathering room, but this only increases the liability to infection, not only from their numbers, which make the air foul, but in addition from their expectoration on the floors and their general unhygienic behavior.

CHAPTER III

FREQUENCY OF TUBERCULOSIS IN INSANE ASYLUMS

By RICHARD H. HUTCHINGS

Attempts to arrive at an accurate estimate of the number of the insane in custody who are tuberculous have not achieved satisfactory results. But little has been published bearing on this point. The New York State Commission in Lunacy, in 1904, estimated that there were among the 25,000 insane in custody in that State 500 cases of tuberculosis, a ratio of two per cent. Dr. Mott investigated the question in the London County Asylums and estimated the ratio of tuberculosis at 1.72. (F. Peterson, '04.)

At the St. Lawrence State Hospital, Ogdensburg, N. Y., in 1904, a careful physical examination of the entire population, amounting at that time to 1,720, revealed 78 cases of tuberculosis of the lungs of greater or less degree. In this test tuberculin was not employed. This percentage is 4.5. In the Middletown State Hospital, Middletown, N. Y., there has been constantly for the past fifteen years about three per cent of recognized tuberculosis, according to a statement of Dr. Ashley, the superintendent. Some very notable investigations on this subject have been made by Dr. W. F. Menzies, who examined 647 patients, the entire population of the Staffordshire County Asylum in 1905, and found positive physical signs of tuberculous disease in 123 and doubtful signs in 133. He gives the accompanying table, showing a

	Numbers.			Percentage on Average Numbers Resident.		
	M.	F.	T.	M.	F.	T.
Admitted during the year	98	80	178	...	...	...
Admitted with positive physical signs	13	6	19	7.54	3	5.20
Admitted with doubtful physical signs	11	4	15			
Admitted who reacted to tuberculin	76	60	136	23.90	17.91	20.82
Deaths from tuberculosis	13	8	21	5.34	2.38	3.82
Other P.M's disclosing active tubercle	4	0	4			
Other P.M's disclosing healed tubercle	16	10	26	5.03	3	3.98
Examined with positive physical signs	77	46	123	42.5	36.82	39.56
Examined with doubtful physical signs	56	77	133			
Examined who are probably tuberculous	..	..	348	...	...	53.78

year's statistics of tuberculosis in that institution with a population of 647.[1]

Though but little has been published in regard to the frequency of tuberculosis in the population of hospitals for the insane, some idea of its frequency can be gained from the mortality from this disease. In a report of the New York State Commission in Lunacy for the year ending September 30, 1906, it was reported that the deaths from all causes from October 1, 1888, to September 30, 1906, in the New York State hospitals had been 28,106. Of these, 4,059 have been from tuberculosis, a ratio of 14.4 per cent. In the annual report of the Government Hospital for the Insane, Washington, D. C., for the year ending June 30, 1906, Dr. William White, the superintendent, gives a statement of deaths from tuberculosis occurring in that institution during the twenty-one years (1885–1906) inclusive. During this period there were 3,746 deaths from all causes, of which 2,102 were examined into post mortem. Active tuberculous disease was found post mortem in 432 cases; latent or limited tuberculosis, post mortem, in 586 cases. There were also during that time 236 deaths from tuberculosis, in which the diagnosis was based on clinical signs and not verified post mortem. Total of all cases of death from pulmonary tuberculosis, clinical and post mortem, 822. Percentage of tuberculous cases among those that died, recognized clinically and at autopsy, 21.9. Percentage of those examined post mortem which showed tuberculous lesions, 27.08.

From the seventeenth annual report of the Asylums Committee of the London County Council there were 1,481 deaths, of which 164 were attributed to tuberculosis. The number of post mortems is not stated. Dr. Menzies, superintendent of the Staffordshire Asylum, states that of the post mortems 68 per cent showed gross signs of old or recent tubercle, and of 51 cases of tuberculosis proved by post mortem examination, 26 had definitely recovered long previously. The State Board of Insanity of Massachusetts reported in 1905 that of the deaths in the institutions for the insane in that State during the preceding year, 14.27 per cent were caused by tuberculosis. In the annual report of the New York State Department of Health for the year ending December 31, 1906, the total deaths from all causes throughout the State were 140,343. Of these, 14,027 were due to consumption, a ratio of 1 to 10; while during the same year there were in the hospitals for the insane in New York 2,071 deaths, of which 345 were attributed to tuberculosis, or 16.6 per cent.

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[1] Annual Report, 1905–1906, p. 18.

TUBERCULOSIS IN HOSPITALS FOR THE INSANE

That this disease prevails to an alarming degree in institutions for the insane is conceded. Its frequency varies in different institutions and in the different wards of the same institution. It is the experience of the writer that there are certain wards in which a case of tuberculosis has not developed in more than eleven years, and other wards which yield one or more cases every year.

The wards in which the disease occurs with greatest frequency are those occupied by the most demented class of patients. These, by reason of their mental condition, cannot be usefully employed; but, on the contrary, they lead sedentary and inactive lives. Many of them are so stupid that any voluntary effort is practically abolished, and they sit in one attitude for hours at a time and until required to change their position. These are the wards in large public institutions which tend to become overcrowded, even when in the institution, as a whole, the overcrowding is not serious. The so-called untidy wards are very apt to be badly overcrowded both day and night. The fact that the wards are crowded renders rather urgent the necessity of keeping people in their places, and the requirement of good order, as construed by the attendants and nurses, is to have each patient seated quietly in his place and to discourage all motor activity. The ventilation under these circumstances is rarely good, and when patients spend weeks and months, and sometimes years, in a ward of this character, it is not surprising that many of them succumb to tuberculosis.

Many of these patients are of untidy and careless habits. They pick up from the floor strings and small objects of any kind and put them into their mouths, and even in some cases the contents of cuspidors find their way into the patients' mouths. The mere fact of patients being crowded together appears to predispose them to tuberculosis, even where the ventilation is regarded as good and the housekeeping is above criticism.

Dr. Menzies, in a report already quoted, speaking of his experience with tuberculosis and dysentery, says:

> Although it is difficult to say how overcrowding can cause disease, provided cleanliness and thorough ventilation are properly attended to, still the fact remains that dysentery, erysipelas, and tuberculosis always increase in overcrowded asylums, and one is driven to the conclusion that infection occurs more easily because the patients are actually placed closer together, and not because the overcrowding produces less efficient attention to the ventilation and cleanliness of the wards and patients.

Those patients who can be employed, and who, therefore, are off the ward a portion or a greater part of each day, unless crowded in sewing

rooms or shops, are usually in much healthier condition and freer from tuberculosis than those remaining in the ward unemployed. At the St. Lawrence State Hospital there are two detached cottages, accommodating together 140 patients, who are employed at garden and farm work, and during the past eleven years not a single case of tuberculosis has occurred in any of these patients, though the disease has shown a steady increase in the institution as a whole. As most institutions for the insane have farms or large gardens attached, it is comparatively easy to find suitable employment out of doors for men, and difficult to find work for the women, except housework and indoor occupations, such as sewing, rug-making, chair-caning, and other more or less sedentary occupations. Let us see how the prevalence of tuberculosis differs in the two sexes on account of this well-recognized difference in the employment of our hospital inmates:

In the period 1888–1906, according to the report of the New York State Commission in Lunacy, there were reported 28,106 deaths from all causes, of which 15,242 were among men and 12,864 were among women. Among the men the deaths from tuberculosis were 1,463, or 9.5 per cent, while the deaths from tuberculosis among the women were 2,596, or 20.1 per cent—more than twice as many deaths among the women as among the men. The mortality among the men from this disease is no higher than that of the State at large, whereas that for the women is more than twice the mortality of the State at large and more than twice that of the men treated in the same institutions.

It would, therefore, seem clear that the extreme susceptibility to tuberculosis among the insane is confined to the demented and inactive classes, and is probably due to the overcrowding, bad air, and lack of outdoor employment.

DIAGNOSIS OF TUBERCULOSIS IN THE INSANE

Tuberculosis occurs with the greatest frequency among the demented and untidy class of patients. In these it is not infrequent for the disease to become well established before the cough is noticed. This is probably due to two causes: (1) A voluntary suppression of the cough by the patient in some cases; (2) in others the irritation in the bronchi does not appear to be sufficient to provoke a cough. It not infrequently happens under competent observation that a case advances to a considerable degree of consolidation before it is even suspected. Indeed, such patients cannot coöperate with the examiner in bringing out obscure physical signs. Consolidation is the first objective sign which can be elicited in many cases. Now that the use of tuberculin has been simplified by the introduction of the ophthalmic reaction, the early diag-

nosis of this disease among the insane will be greatly facilitated, and in those wards in which experience has shown the disease most frequently develops the patients should be tested from time to time.

TREATMENT OF TUBERCULOSIS IN THE INSANE

Prevention of Tuberculosis.—It is now generally recognized that among the insane, as elsewhere, tuberculous patients should be removed from contact with the healthy and afforded the treatment, as far as possible, which is now recognized to be the most appropriate for all tuberculous affections. To this end, all patients, at the time of admission to hospitals for the insane, should be examined carefully for the presence of this disease, and when the condition of the patient is such that it cannot definitely be excluded by examination of the lungs, the use of tuberculin, preferably the ophthalmic reaction, should be resorted to in every case.

Overcrowding of wards and dormitories should be avoided, and particularly those wards occupied by the demented and inactive classes. In these wards the patients should be dressed warmly and fresh air should be admitted in such quantities as to effectually do away with all foul air in the wards. All patients physically able should be exercised and, if possible, employed in the open air daily. The clothing worn by one patient should not be worn by another until it has been disinfected. The danger here is particularly in the use of shawls, hoods, and wraps for the neck. A bed that has been occupied by one patient should not be used by another until the bedding has been disinfected.

The use of drinking cups attached to ice-water tanks should be done away with, and drinking fountains, such as are now in use quite generally in public buildings and schools, should be substituted. A room occupied by a patient known to be infected should be fumigated before another patient is assigned to it.

Individual Treatment.—Where it is possible to do so, tuberculous patients should be segregated and cared for in a pavilion, where the same treatment can be given as in sanatoria generally. Such pavilions have been in use at the Binghamton State Hospital and the St. Lawrence State Hospital for four years and two and a half years respectively, and their operation has been attended with no unfavorable results on account of the mental condition of the patients. On the contrary, the results have been in every way satisfactory. The insane, particularly of the class in which tuberculosis is most common, adapt themselves rather readily to the routine of such an institution, and their care offers no insuperable difficulties in the great majority of cases.

A larger proportion of nurses is required to give them proper super-

vision than in the ordinary asylum wards, but it should be borne in mind that, as a class, they are liable to certain dangers which need not be considered in an ordinary sanatorium. In cold weather they are apt to get the clothing disarranged, suffer unduly from cold, and even to have exposed portions of their body frozen without complaining. Others may wander about and come to harm. In others a tendency to suicide or homicide may be present, which should carefully be guarded against.

The patients should be so classified that those who require but little attention, or can care for themselves, will be together in one ward or in one group, while those who require the maximum of care will be kept together and particular provision made for their supervision. In this way a few who require it may have the undivided attention of one or

FIG. 21.—TREATMENT OF THE TUBERCULOUS INSANE ON AN OPEN PORCH. (Winter of 1903, St. Lawrence State Hospital, Ogdensburg, N. Y.)

more nurses, as may be necessary, to carry out the plan of treatment and prevent reinfection and other dangers referred to. In general terms, it may be said that one nurse may give proper attention, on an average, to five patients during the day, and four times that number at night.

Many of the insane, as has been observed in children, have a tendency to swallow their sputum, yet the more intelligent can be trained

to use a sputum cup. A certain number will persist in expectorating on their clothing or on the floor. Such patients should be surrounded by rugs or sheets spread on the floor and moistened with an antiseptic solution, and these rugs should be sterilized frequently by boiling. For an exceptional few who, by reason of delusions, will circumvent such simple precautions, well-ventilated single rooms should be provided, which will permit of easy and perfect sterilization.

For those who refuse food, the stomach-tube should be used not less than three, and preferably four or five, times a day. Milk and eggs form the staple article of liquid diet used in such cases, which should be supplemented with beef juice, barley or cereal water, sugar, and occasionally fruit juices. Where a separate pavilion cannot be provided, excellent results have been obtained by segregating the tuberculous insane in tents, as is done at the Manhattan State Hospital and the Willard State Hospital in New York.

Dr. A. E. McDonald, Superintendent of the Manhattan State Hospital, New York, was the first to treat insane tuberculous patients by means of camp life.

Fig. 22. — A Cold-proof Sleeping-bag and Method of Adjustment. (Winter, 1903, St. Lawrence State Hospital, Ogdensburg, N. Y.)

That consumptive insane patients may be kept and treated to their advantage, and incidentally to the advantage of their fellow inmates, in canvas tents, and throughout the several seasons of the year, would appear to have been demonstrated in the recent history of this hospital. The experiment upon the success of which this claim is advanced has, at the date of this writing, covered a period of forty months.

The first intention and expectation were that, by possibility, the consumptive insane patients, or a majority of them, might be removed from contact with their fellows for some months, perhaps as many as five months, during the milder season of the year, with the attendant advantage of freeing for the time being corresponding space in the permanent building and affording opportunity for disinfection and renovation. As

the weeks passed, however, and the patients continued comfortable (the tents were heated with large stoves in cold weather), evacuation was deferred until a severe storm occurred. Then it was that, in spite of high wind and snow, a more equable temperature had been maintained and less discomfort caused in the tents than in the hospital wards most exposed to the force of the gale. From that experience, followed by other confirmatory ones, resulted the reconsideration of the design to evacuate the camp.

FIG. 23.—TREATMENT OF THE TUBERCULOUS INSANE IN A SOLARIUM WARMED BY STEAM BUT WITH WINDOWS RAISED. (Winter of 1903, St. Lawrence State Hospital, Ogdensburg, N. Y.)

The isolation of the tuberculous patients has reduced to a minimum the danger of infection of other patients and of employees. The patients themselves have suffered no injury or hardship, but have, on the contrary, been unmistakably benefited. This is shown, among other ways, by a decrease in the death-rate from pulmonary tuberculosis, both absolute and relative, and by a marked general increase in bodily weight, amounting in the case of one patient to an actual doubling of the weight—from eighty-three to one hundred and sixty-six pounds—in fourteen months of camp residence.

As an interesting incidental fact it may be mentioned that not only the patients, but also the nurses living in the camp, have enjoyed almost complete immunity from other pulmonary diseases; not a single case of pneumonia has developed in the camp in its existence of over three years, though it caused 131 deaths in the hospital proper in that time.[1]

[1] Ninth Annual Report of the Manhattan State Hospital, New York City, 1904.

PART III

SYMPTOMATOLOGY AND DIAGNOSIS

INTRODUCTION

TUBERCULOSIS IN CHILDHOOD [1]

By CLEMENS VON PIRQUET

The diagnosis "tuberculosis" thirty years ago was equal to a death sentence. In the following years a milder prognosis was made—it was said that death could be delayed in especially favorable climatic surroundings. Still some years later the conception that many cases were curable received more general approval, and now we have arrived at the conclusion that the dreaded tuberculosis is a disease of relatively small danger, since it kills only about seven to ten per cent of all those infected.

This change in our conception has not been brought about with the beginning of a new therapeutic era, not with the discovery of a great specific remedy which can cure the disease in a most unexpected manner, but simply by the different prognostic conclusions based upon a greater refinement of diagnostic methods.

An analogy to this may be found in some diseases of trees which formerly were recognized only by the fact that the boughs would fall in a certain way just before the tree died. Then it was recognized that caterpillars had bored themselves through the sap-ducts of the tree, destroying them, and, further, that also such trees showed furrows made by caterpillars, without having been killed by them. Finally, the moth, which produces the caterpillar, and the eggs were recognized, and it was observed that the latter were deposited in almost every tree, but that most of the trees opposed a resistance to the development of the

[1] Dr. von Pirquet's article does not undertake to review the subject systematically. Articles dealing with detail questions relating to tuberculosis in children and of particular interest to the practitioner will be found in other parts of the book. But it seemed of particular value at this moment to give to the reader an entirely subjective expression on tuberculosis in childhood based upon Dr. von Pirquet's own investigations. As such it is hoped that this contribution from our most recently acquired American author will prove both interesting and stimulating. The author wishes to add, however, that the views expressed in this article are in many points based on work and views of Koch, von Behring, Naegeli, Cornet, Bang, Bartel, Finkelstein, and especially F. Hamburger. He apologizes for not having made any references in the text to the work of others.—The Editor.

caterpillars. And to-day it is not necessary any more to saw the tree to pieces in order to discover the furrows of the caterpillars or to search for the eggs; it is sufficient to recognize in the minute alterations of the bark the fact that the moth has deposited its eggs, and we need only take a leaf, immerse it in the poison of the caterpillar, and demonstrate by its discoloration whether the tree is already infected or not.

Thus tuberculosis was formerly recognized only in one of its terminal stages, pulmonary phthisis, when the lung was so far destroyed that its excavation produced a distinctly altered finding upon physical examination, together with a marked emaciation of the whole body. Then the identity of this dreaded lung disease, with many other chronic, though not so unconditionally fatal, diseases of the bones, joints, and serous cavities, was established. Then the tubercle bacillus was discovered, and it was found not only in phthisis, but also in the sputum of persons without emaciation, and no, or only slight, alterations of the physical phenomena in the lungs; it was even discovered at the autopsy of bodies of people who had died from entirely different diseases. Soon it became apparent that the small caseous foci of lymph glands which were found accidentally in most autopsies were also produced by the infection with the tubercle bacillus; and, finally, it was possible to demonstrate by the reaction to tuberculin that almost everyone at one time or other of life had been infected, but that this infection led to a clinical disease, or even to death, only in a relatively small percentage of the cases. Of great importance was the discovery that these infections took place already during childhood, so that at fourteen years practically everybody had already been subjected to it.

If it is true that the majority of people are infected during childhood, it must be concluded that the most useful revelations about the incipient stages of tuberculosis are to be expected from the investigation of pediatricians. The whole pathology of adults demonstrates only chronic processes or reinfections or terminal stages of the disease, the beginning of which must be referred to childhood.

And it is just this very first acquaintanceship with the causative factor of the disease which primarily merits our attention.

Portal of Entrance for Infection.—The first infection of the organism takes place most probably in the majority of cases through tubercle bacilli which are expectorated with the sputum of chronically diseased adults, and which enter the lungs of children with dust or in the form of "droplets." Here the bacilli penetrate the mucous membrane, which does not yet react with defensive measures, and they reach the regionary lymph glands in the hilus. Here they multiply according to the laws of their species, the same as on a favorable medium. The products of their excretions stimulate the formation of antibodies; the organism

forms antagonistic substances which "digest" and remove the bacilli and their poisons. The tubercle bacilli, however, are not as easily destroyed as other pathogenic bacteria; they are protected by a waxy coat and remain alive in places where larger colonies have been formed. But here they are, in a sense, "locked in." The cells surrounding them multiply and die, around the focus a necrotic zone is formed, the lymph gland swells, degenerates, caseates.

Other Portals of Entrance.—Infection through the lung is not the only possible, but the most frequent, mode of entrance of the tubercle bacillus. It can also use other routes, if the portals are accidentally open. Thus the diphtheria bacillus, for instance, first invades the tonsils, but if it accidentally reaches an irritated vulvar mucosa, or an intensely eczematous epidermis, it can find here also favorable conditions for a foothold. In the same way also the tubercle bacillus can be inoculated into some part of the epidermis or mucosa. Of the numerous tubercle bacilli which are swallowed and which proceed through the intestinal canal, very rarely one finds a chance to enter the mucosa capable of producing here a primary lesion. In practical pediatrics this route seems to play a very insignificant rôle.

Clinical Stages.—We have no accurate knowledge as to the duration of the primary stage of lymphatic-gland infection. It is possible that the tubercle bacilli remain a long time deposited in the lymph glands, without any signs of multiplication and without producing local or general reaction. But in analogy with other infectious diseases and from the experiences with bovine tuberculosis it seems probable that the formation of antibodies, and with it the reactivity of the organism, begins with the second week after the infection, and is increased until the primary process has found an apparent termination. These primary stages have so far escaped clinical recognition, but it is to be hoped that they will become accessible for our diagnosis through a further refinement of methods of examination. It is presumable that the first eight to ten days after the entrance of the tubercle bacillus produce no discernible symptoms, and that hereafter through several weeks a slight fever and general malaise may be observed.

The swelling of the lymph glands, furthermore, can be observed symptomatically only when producing a mechanical obstacle. *The tuberculosis of the hilus glands* leads in small children frequently to chronic dyspnea. In the radiogram we then find the enlarged bronchial gland, and the tuberculin reaction elicits their tuberculous nature.

The enlargement of the hilus glands, however, is in most cases not so considerable that it exerts a pressure on the trachea, and the only sign pointing to a previous infection is to be found solely in the presence of a reaction to tuberculin, in the "allergy" to tuberculin.

These bacilli are only harmless foreign bodies for the organism that has never previously come in contact with tubercle bacilli. Here they penetrate without hindrance the membranes, and so does also the extract of such bacilli; the tuberculin is for such an organism an indifferent substance, which it tolerates in every form and quantity. If, however, this organism has once been infected, it has altered its reactivity toward tubercle bacilli and its products; it has become allergic. The allergy (*allos*—changed; *ergeia*—capacity to react) is apparently based on the fact that the organism possesses antibodies, which digest the bacillus and its poisons. But the products of digestion are not harmless, but toxic bodies for the neighboring cells and tissues.

Within the allergic body tuberculin produces a quantitatively graduated production of poisons. If it is injected subcutaneously, fever is produced; if dropped on the conjunctiva, conjunctivitis is set up; and if inoculated into the epidermis, a local inflammation follows. In the same manner the allergic body is no more indifferent to the tubercle bacillus itself. The bacillus can no more penetrate without hindrance the mucosa and reach the lymph glands, but it produces already at the portal of entrance local inflammatory changes, which usually heal. If, however, a very virulent bacillus resists the attack, a necrotic process takes place at this point. If the allergic man, for example, is subjected to a new infection in the lung, a cavity is formed. This pulmonary form, typical in the adult and found but rarely in children, is therefore most probably the effect of a reinfection in individuals who have become allergic through a primary infection in childhood.

We will now return to the consequences of the first infection. In most cases during primary infection of older children the tubercle bacilli do not penetrate beyond the regionary lymph glands, and with caseation and the production of allergy the pathologic process is provisionally terminated.

This primary infection with a termination into a nonapparent, nonperceived tuberculosis of the lymph glands has this advantage, that the organism enjoys, through the allergy produced, a certain, though incomplete, immunity against renewed infection. It has, however, the disadvantage that an encapsulated focus containing tubercle bacilli is carried around which at any time can inundate the body from within with its pure culture.

Progression of the Infection.—It seems, however, that a localization of the process by the described mode takes place but rarely in very small children. It seems that for this an already general resistance to bacteria is needed by which the bacilli are permanently retained in the lymph glands, or it may be that the antibody formation takes place too late, or perhaps that especially favorable conditions for growth are en-

countered by the bacteria. At any rate, here we find almost always a transition into a fatal tuberculosis. The character of the disease is essentially different from that of the adult. Nurslings do not die from the poisoning, nor from a far-advanced local disease, nor from the slow "carcinomatous" disintegration of their lungs, nor from secondary mechanical obstructions, but from the *general lymphatic infection.* It may be said they are overwhelmed by tuberculous formations through the lymphatic route. Death in this case takes place either with a general atrophy or by the breaking through of tubercles into the lungs or into the venous system, producing thereby a tuberculous bronchopneumonia or a miliary final stage.

With this we reach the second cause of the general tuberculous disease—the mechanical breaking through of the lymphatic system, an incident which can happen throughout the whole period of childhood. The caseous focus in the bronchial lymph gland corrodes the wall of a vein, the bacteria enter the general circulation, producing a dissemination, the clinical importance of which is dependent on their number and the region where the bacilli are deposited. It is, however, entirely immaterial whether the primary focus in the lymph glands was of considerable size or whether it produced clinical symptoms. An exceedingly small focus containing only a thousand bacilli can give origin to a dissemination throughout the body, provided they are evenly distributed by the circulating blood. Therefore we often see the onset of most severe symptoms of this kind in children who previously seemed entirely healthy.

Whenever the number of bacteria is very large, a *general miliary tuberculosis* is produced, which in children almost always is fatal under the guise of an acute hydrocephalus. While in the adults a preponderance of pulmonary symptoms is observable in miliary tuberculosis, in the child the most important consequence of the general dissemination is the increased secretion of the ependyma, which produces a hydrocephalus internus and the characteristic symptoms of *tuberculous meningitis.*

At autopsy one finds in these cases in almost every organ miliary tubercles of the same age, which, because of their unimportant localization, made no impression on the picture of the disease. With small numbers of disseminated tubercle bacilli it is entirely a question of localization which determines whether clinical symptoms will at all appear, or whether it comes to a fatal termination. During the past years we have become acquainted with the *tuberculides,* which apparently also represent a miliary dissemination, which when only attacking the skin would be borne without consequences. At autopsy one finds, however, often aside from fresh miliary tubercles, older foci in the

spleen and kidneys, which originate from a previous insignificant dissemination.

It is very likely that the foci which are developed in the bones, especially in the phalanges, in the vertebral column, etc., originally were produced by a miliary dissemination, of which only a few germs found favorable conditions for growth.

We do not know what constitutes these favorable conditions. It is easily possible that bacterial invasions starting from tuberculous foci are no rare events, but that a vigorous organism destroys the germs before they are able to form new colonies. It is quite certain, however, that some definite conditions exist under which the tuberculous dissemination becomes especially harmful.

Anergy.—In this direction the influence of measles is best known. In children with latent tuberculosis or with a manifest, localized tuberculosis, we observe frequently during the course of measles a renewed dissemination, ending quite often fatally as miliary tuberculosis or leading to the formation of fresh foci in the shape of skin tuberculides, scrofulous manifestations, and localizations in lungs or bones. It has been found recently that no tuberculous child reacts to tuberculin during a definite period of the measles process. If one makes daily tuberculin tests in children who, because of their localized glandular tuberculosis, are allergic, one finds a complete disappearance of reactivity with the beginning of the exanthem, and its reappearance again only after about one week. During this one week the organism is, therefore, "anergic"—i. e., nonreacting. It may be supposed that the measles process occupies the antibodies which are needed for the repulsion of the tubercle bacilli present in the body. During this unprotected period the tubercle bacilli can grow through the necrotic protective wall of a caseous gland, or secondary diseases can also occur, because now the circulating tubercle bacilli can find favorable conditions in the tissues, where at other times they would have been killed. Similar conditions are not found in the other children's diseases, as scarlatina and diphtheria, but probably during the course of several other diseases which are known to be particularly apt to prepare the field for tuberculosis, as, for instance, influenza. And it seems to me also quite likely that the progress of tuberculosis in the adult is also frequently promoted by similar temporary diminutions of resistance. The point of comparison lies in the general defenselessness which we encounter in such conditions. Thus the patient with measles is not only particularly susceptible to tuberculosis, but also to diphtheria, influenza, and all germs with which he accidentally may come in contact; and similarly, during pregnancy, not only does the tuberculous process frequently spread, but, for instance, caries of the teeth can also rapidly increase. We know that the spread of tuber-

culosis in the adult—that which up to now has been called the "incipiency of tuberculosis," as, for instance, the manifestation of clinical phenomena—usually follows conditions of general debility, produced during a period of severe physical exertion on a poor diet. I should like to draw the analogy between this whole category of generalization in tuberculosis and the experiences with measles, which, however, require more precise definition.

Scrofulosis.—A counterpart of anergy during measles is the hyperergy, which we are accustomed to see in the scrofulous forms of tuberculosis. The etiologic identity of the old clinical conception of scrofulosis and tuberculosis, doubted on the basis of cellular pathology, has become theoretically assured through bacteriologic studies and the practical exploitation of the tuberculin reaction. We have here a form of tuberculosis particularly frequent during childhood and characterized by multiple tuberculous foci, with abnormally increased reactivity.

Does this hyperergy, this exaggerated reactivity, indicate effective protective measures, or is it the expression of a certain anomalous formation of antibodies, or is it only a consequence of a subjective susceptibility of the tissues against tuberculous products?

The child with hyperergy certainly reacts very intensely to the tubercle bacilli disseminated in its organs, and at every point of deposition within the body extensive necrotic changes are produced, and where the skin or mucosa comes in contact with tuberculous products intense superficial irritations take place.

The type of scrofulosis is determined by the multiple swellings of the lymph glands. To this are added the swelling of the nose, the chronic eczema at its entrance. On the conjunctiva there form phlyctena, formations which can also be produced through instillation of tuberculin, and resemble very much the efflorescences produced by rubbing tuberculin into the skin, and also to those seen surrounding the intensely inflamed cutaneous papule ("scrofulous" reaction). If foci are present in the subcutaneous tissue, cold abscesses are formed there, which are covered by a skin of a purple discoloration; similar cold abscesses develop also in the bones.

Multiple localizations of tuberculosis fought by a hyperergic constitution seem to allow a better prognosis; at least we see the greater part of "scrofulous forms" heal gradually, and at a later age period it seems that the previously scrofulous individuals possess a certain resistance against pulmonary tuberculosis. But with this it must not be inferred that the termination of scrofulous forms must necessarily be favorable; especially in earliest childhood many hyperergic individuals succumb also.

Prophylaxis and Therapy.—A prevention of tuberculous infection is, absolutely speaking, not possible under given conditions, because we can-

not bring up our children removed from all intercourse with infected individuals as we are able to do with cattle. The most important, however, is to protect them from infection during the first years of life, because the infection during that period is the most dangerous. We will have to look out that no one with open tuberculosis shall be in the environment of the child, and we will eventually have to remove it from a tuberculous father or mother.

If we recognize, from a positive reaction to tuberculin, that an infection has already taken place, then the prognosis will depend on the age of the patient and the clinical manifestations. The prognosis has to be formed with great caution during the first years of life. A positive tuberculin reaction in older children has a serious significance only when symptoms of an affection of the lung, the bones, or the serous membranes are to be found, or when there is emaciation, anemia, and anorexia. In those cases a general climatic and dietetic therapy is to be recommended.

CHAPTER I

SYMPTOMATOLOGY OF PULMONARY TUBERCULOSIS

By CHARLES L. MINOR

INTRODUCTION

When we take up the study of the clinical manifestations of pulmonary tuberculosis as revealed by its various symptoms and signs, and try to separate its varieties into distinct and sharply differentiated types and to correlate these with certain fixed pathological conditions, we find the task a very difficult one, and a reference to the different authors who have written on the disease shows numerous attempts in this direction but no uniformly accepted results. The reasons for this lack of uniformity are obvious; from the first early evidences of the disease to those of the most advanced trouble, pulmonary tuberculosis shows a marked polymorphism and, more especially, such a combination in one and the same case of various conditions, both clinical and pathological, as to render a very sharp distinction between types impossible.

The well-recognized fact that one form of the disease may change into another, chronic cases either changing their type or becoming acute, acute cases sometimes becoming chronic, makes it difficult to draw a line where one type ceases and another begins.

Again, it is known that there can exist in the diseased lung, at one and the same time, areas of different kinds of pathological condition —fibrosis, ulceration, acute bronchopneumonia, miliary tuberculosis, etc. In view of these facts it is evident that any attempt at a close correlation of pathological conditions with clinical manifestations is doomed to failure, and that while for practical purposes it is necessary and desirable clinically to distinguish different types of pulmonary tuberculosis, the dividing line between different forms must not be too sharply drawn, nor must we try to fit our cases too closely into these more or less arbitrary frames.

The *types of the disease* generally recognized are, in their most simple statement, chronic phthisis, acute phthisis, and acute miliary tuberculosis. Many subdivisions of these main heads have been suggested, some based on etiological, some on pathological, and some on symptom-

atic grounds, but too great a minuteness has no practical value and can only lead to confusion, and it is better, while recognizing the different ways in which the chief types may be modified, to multiply divisions as little as possible.

Chronic Phthisis.—The cases of this type form the large majority of those seen, and for all practical purposes are the only ones in which therapeutic efforts are of any use. Aside from those rare cases which begin as acute phthisis, or even sometimes acute miliary tuberculosis, and later, by some happy chance which we cannot ascribe to our own skill, become chronic, chronic cases may be said to begin in one of two ways, as was pointed out by Ruehle. Either in the beginning there is a gradual and progressive loss of vitality and nourishment not typical of any special disease and frequently mistaken for neurasthenia, dyspepsia, or anemia, this being followed after a longer or shorter period by more distinct symptoms of the disease, such as cough, expectoration, fever, etc., or else, in the midst of good health the patient develops symptoms which are at least suggestive of phthisis, although they are too often ascribed to bronchitis, grip, malaria, etc., and it is only after these have lasted for some time that the decline of strength, emaciation, etc., appear, and the picture becomes so distinct as to be no longer mistakable.

The latter beginning is the more common, but the former is more frequently the cause of diagnostic errors, and it cannot be too insistently noted that every patient complaining of loss of vitality, nourishment, color, etc., which cannot be satisfactorily and clearly accounted for, should be regarded as possibly tuberculous and carefully examined for signs of the disease. These patients are below par, feel poorly and run down, and there is undue languor and weariness—two very early symptoms. The patient lacks his usual energy and snap, tires out quickly, and is not refreshed by rest or sleep. These are the cases which are supposed to be neurasthenic, while others, beginning with anorexia and indigestion, are called chronic dyspepsia; or, if the patient becomes unduly pale with tachycardia, hemic murmurs, etc., he is treated by hematinics. Sooner or later, however, definite symptoms appear; a slight cough, dry at first, a little fever, often unnoticed by the patient, an occasional sweat, or perhaps fortunately, a slight hemoptysis.

When the case begins with definite symptoms, the most usual is a cough, ascribed to "catching cold," or a definite acute cold resembling bronchitis or grip, or at times an attack of what looks very much like mild typhoid. The "cold" is obstinate and will not be cured, the "grip" or "typhoid" does not convalesce properly, a cough with expectoration persisting or developing, though this at first tends to disappear with warmer weather, only to return in the fall, some cases

having these summer ameliorations for a number of years before a diagnosis is made. The fever begins to manifest itself actively at intervals, the expectoration increases in amount and becomes more yellow and thick, with possibly some blood-streaking or a small hemorrhage. In some fortunate cases hemoptysis is the first symptom, coming on in the midst of good health, either without discoverable cause or after overexertion. A sudden irritative cough develops, followed by a hot feeling in the chest, and a mouthful of bright blood comes up. As is noted elsewhere under "hemorrhage," such blood spittings are with such few exceptions tuberculous in origin, *that only the very strongest evidence to the contrary should justify us in dismissing the diagnosis of tuberculosis after such an hemoptysis, even if symptoms and signs are absent,* for the history of these cases teaches that practically all of them sooner or later develop evident symptoms of the disease, and it is far better to treat them all as tuberculous, even if the case is prevented from ever reaching the stage of symptoms, rather than to calm their fears by assuring them it was just a "broken vessel." At this point I would note that a certain number of cases are latent or abortive, though they need not be made into a special class by themselves; the initial symptoms which are often not recognized at all, slowly disappearing either before or after a positive diagnosis can be made. The cough ceases, the weight returns to normal, and the process is either arrested permanently—these cases being those in which autopsy reveals old scars in apices—or for many years, to break out again during some period of depressed vitality. The histories of cases of tuberculosis very frequently reveal indications of one or more past abortive attacks of this sort.

Usually, however, the course of chronic cases, whether it be of the commoner ulcerative form or of the more favorable fibroid form, tends to be slowly progressive, interrupted by longer or shorter intervals of remission, but never by a complete cessation of the symptoms. The temperature, which is at first absent for considerable periods, becomes more persistent and higher, the nourishment slowly decreases, and each new exacerbation leaves a larger area involved. Signs of moisture appear, a very slight hectic flush shows itself in the cheek, and the cough becomes deeper and looser. The expectoration is now abundant and takes on the characters noted under "expectoration." The fever becomes more and more persistent and obstinate and finally hectic. Emaciation advances to a pitiful extent, the skin in some cases being tensely drawn over the bony prominences, and the feverishly bright eyes looking at us for help from the bottom of deep pits.

The end is usually by exhaustion, and is generally remarkably easy and peaceful, but if diarrhea, laryngeal ulceration, or meningitis occur it can be extremely painful and terrible, or where excavation is marked

may be brought about by a single large hemorrhage which is either instantly fatal or kills through a rapid, acute dissemination or pneumonia.

Where the patient's vitality is poor, either hereditarily or as the result of unwise living, or where the build is congenitally bad, the course is naturally apt to be severe and the outcome bad. On the other hand, in the wiry, with good resisting powers, or in those with a gouty or rheumatic tendency, the disease usually has a favorable course, with a marked tendency to the deposit of fibroid tissue around the lesions in the lungs and with less active symptoms. Andrew Clark, in England, was the first to describe fibroid phthisis as a separate type, and Sokolowski, in Poland, has given it special study.

In this type, if we admit it as such, the whole course is much less active and the duration long drawn out. The fever is often absent and sweats unusual, but, in its later stages, hemoptysis common. As a result of the shrinkage of the fibroid tissue there is progressive distortion of the chest, as well as the formation of bronchiectases, with paroxysmal cough. Dyspnea is also very marked. This form is apt to occur in patients after forty and has a chronic and tedious course. Where the course is progressive, large inactive cavities slowly form; but, owing to the location of the cavities in the deeper portions of the lungs, the physical signs are indefinite. Marked dislocation of the heart is also seen.

Such typically fibroid cases, while slow in their course, are usually fatal in their termination, and are not to be confounded with cases in which, as is necessary in tuberculosis, the healing is brought about through fibroid encapsulation, but in which the fibrosis is not so generally marked as in the cases described.

Some fibrosis is present in every case of tuberculosis, as well as some ulceration; if the former is very marked, the course is slow and the outlook more favorable; if the latter predominate, the contrary is the case; but it is not always possible to draw any sharp line, the majority of cases showing a combination of both processes.

The commencement gives no reliable clew to the future course of the case, for a severe active beginning may be followed by a favorable course and cure, and vice versa; though usually a gradual onset speaks for a mild infection and good powers of resistance.

Some cases, with very slight improvement in the conditions of their life, have such excellent recuperative power as to throw off the trouble quickly; others demand the cessation of all work, the best of conditions, and the most favorable climate if they are to pull through at all; while yet others, from the first, show no powers of resistance to the advance of the disease, despite the very best of opportunities, and run a steadily downward course. The duration in earlier days, when a diagnosis could not be made so easily and when treatment was less effectual, was placed

at two to three years, but the average is now more justly stated at about ten years, with variations all the way from one year to twenty or thirty or even more years.

When improvement occurs it is usually very gradual, though cases removed to a favorable climate and under the best of conditions will often recover quite rapidly. On the whole, it is fair to say that "apparent cure" demands from six months to three years, from one year to eighteen months being the average, and that such a case must hold its own in every way for two to three years before it can be called "cured."

The temperature is usually one of the first symptoms to show improvement, and the cough the last. Under outdoor treatment the sweats cease very quickly, expectoration becomes much whiter and, at first, more abundant, later lessening, and finally disappearing, usually a long time before the cough. Appetite, unless there be a bad dyspepsia, returns soon in favorable cases. Weight begins to increase even in summer time. Normal energy and strength reappear, and long before the cough disappears the patient looks and feels as well as or better than ever in his life. In favorable incipient cases the "apparently cured" case may anticipate the resumption of his occupation in his old home if his surroundings are of the best and his life of the wisest, but, in proportion as the recognition of the disease is delayed, a retention of the restored health will demand more and more favorable conditions of climate, surroundings, and occupation, and in the more advanced cases the patient should be well content if, by giving up all work and living in the very best possible climate, he can live as an arrested case.

Acute Phthisis.—Acute phthisis arises either as the result of the mobilization of the bacilli from some unsuspected focus, probably most commonly a bronchial lymph gland, or else develops in the course of a chronic phthisis. Two types are usually distinguished—the *acute caseous* or *tuberculous pneumonia*, which is lobar in type, and the acute disseminated tuberculosis or bronchopneumonic phthisis, lobular in type. Both are of short course, three weeks to six months, and of almost uniformly fatal outcome. It should be remembered that the clinical picture may often be indistinct, running in the borderland between the mild, acute type, and the more severe chronic one. Many chronic cases have periods when more or less extensive areas of acute phthisis exist in the lung, which may or may not go on to pronounced acuteness, and only the relatively small extent of these acute areas can differentiate these cases from acute ones. In fact, as several authors have pointed out, the symptoms and signs of the two types differ only in their intensity and in the time in which they take to develop, the symptoms of an acute case being only those of a chronic one raised to a much higher power and concentrated in a much shorter time.

Of the two types of acute phthisis, acute caseous pneumonia is most apt to rise *de novo* in an apparently well person—often in the athletic; the other form, which is more chronic, usually originating in a patient who is already frankly tuberculous.

Acute caseous pneumonia appears usually under the guise of ordinary lobar pneumonia, with a chill and sudden rise of temperature, though the pain in the side is apt to be absent. The sputum is generally rusty, and since bacilli are not found in it, it cannot be distinguished from real pneumonia, unless, as is at times the case, it follows a sudden hemoptysis, such pneumonias always being presumptively tuberculous.

For the first few days the course is that of an ordinary pneumonia, the fever being continuous and typical, and while there is undue prostration it is not sufficiently marked to be diagnostic. In the second week, however, our suspicions will be awakened. Instead of a crisis occurring, the fever becomes irregular, and later may be hectic, with chills and sweats, and resolution does not appear. The great dyspnea is suspicious, as is the unusual pallor and especially the cyanosis, while the sputum tends to become profuse and olive-green in color, and after two or three weeks bacilli may be discovered, although death may occur before they appear. When the course is very acute, the end comes by exhaustion in three to six weeks; but the course may be subacute, and then the consolidated areas have time to show signs of softening, which may go on to cavity formation; while new extensions appear in other portions of the lungs, first manifested by fine, dry crackles, changing quite rapidly to fine and medium moist râles, with which small areas of dullness will soon be associated. In one case of mine, where the initial trouble was a massive consolidation of the upper left lobe, later extending to the lower, small patches of bronchopneumonia developed in the front and back of the right lung, while the left upper lobe was going on to complete excavation. Strange to say, despite the marked exhaustion, nourishment remains very good for some time and the appetite is quite fair. Where the course is prolonged, as it may be for from two to six months, the end, if not by exhaustion, is apt to be by meningitis.

The second and more ordinary form of acute tuberculosis is the *acute ulcerative lobular phthisis* of the French, or the *acute disseminated tuberculosis* of Fraenkel, popularly and graphically called "galloping consumption." As the name indicates, it is bronchopneumonic in form and very rapid in course, with great destruction of tissue, if life be sufficiently prolonged. It is very common in childhood and adolescence, as a result of measles and pertussis, as also in the course of exhausting maladies, such as grip and typhoid, and more especially

diabetes, while the tuberculosis which develops after pregnancy and runs a rapidly fatal course is of this form. It can also develop in the course of a chronic tuberculosis as a result of a large hemorrhage (Bäumler), these being the acute disseminations seen sometimes after hemoptysis, or it can arise through the aspiration of the contents of a cavity. Fraenkel divides it into three varieties, the hemorrhagic, the peribronchitic, and the disseminated ulcerous, but such minuteness of division I do not believe desirable. The rapid destruction characteristic of this type has by some been ascribed to mixed infection.

The beginning in patients not apparently tuberculous can be very sudden, resembling an attack of grip, with chilliness, aching of the joints, fever, cough, and expectoration; while in the tuberculous it first appears under the guise of an exacerbation of the trouble with increase of the already existing symptoms. In either case the development is rapid, the color fades away quickly, the pulse becomes fast, and the expectoration, which is at first mucoid and scanty, and may be temporarily rusty, as separate areas of bronchopneumonia form, finally becomes purulent and abundant and swarms with bacilli; though in cases arising in the apparently healthy, germs may not appear for some time. The cough is severe and fatiguing, and dyspnea and cyanosis marked, the former being out of all proportion to the physical signs. The fever is high and intermits once or more a day, with chills and profuse sweats. The physical signs are those of bronchopneumonia, with fine and medium moist râles, and though widely disseminated they show a tendency to localize themselves (Grancher). Impaired resonance soon appears, and later signs of excavation, the lungs seeming to melt away from day to day under the virulence of the process. Emaciation may be very rapid and is more common than in the lobar form, but, as in that form, it is not always present. Usually the course is from two to six months and the end comes by exhaustion, hemorrhage, meningitis, or the development of acute miliary tuberculosis. In some cases the rapidity of the fatal course is extreme—a case in my practice dying in three weeks from the date of an anesthesia which brought her chronic tuberculosis to activity. Some cases, desperate as they are, surprise us by a gradual lessening of the intensity of the process, and again become chronic for a time, but a real recovery from this type of the disease must be extremely rare.

Acute Miliary Tuberculosis.—Acute miliary tuberculosis is not so much a pulmonary as a constitutional disease, but, save in its meningeal form, which need not be dwelt on here, it has pulmonary manifestations of sufficient importance to demand a description. It appears under three forms—typhoid, bronchopneumonic, and meningeal.

The typhoid form is the result of a general systemic infection, hence

the French name of *septicémie bacillaire* or *typho-bacillose*. Like all such infections, it usually has a prodromal stage of from one to three weeks, during which the patient is languid, has dull headache, anorexia, and a slight, generally overlooked fever. The active stage begins with high fever, which at first is continuous and not to be distinguished from typhoid, though later it is irregular, with marked remissions, or even intermissions, of one or two days.

The general resemblance of the symptoms to typhoid is so close that the best diagnosticians have often been deceived, and in many cases only an autopsy can make the distinction. The prostration is greater than is usual in typhoid and the headache severe. Anorexia is the rule, as is constipation, but diarrhea may be present, and, to add to the difficulty, rose spots can be found in some cases and the spleen and liver are enlarged. The pulse is weak and unduly fast (130–150), unless meningeal involvement exists, and there is hyperesthesia of the skin and underlying muscles (Empis), especially of the abdomen and chest. The cough is not different from that seen in the beginning of typhoid, and the scanty sputum is aërated, mucoid, and shows no bacilli, and the physical signs are at this time only a few sibilant râles here and there, later replaced by fine moist râles, fixed in location, but appearing and disappearing. Faint frictions, due to subpleural tubercle (Jürgensen), can also at times be found. Percussion is negative. In suspicious cases the lungs must be watched closely if we are to discover the ofttimes very slight auscultatory changes. As in all acute cases, the two most typical symptoms are the undue dyspnea and the cyanosis. The former appears early and continually increases. The latter is especially noticeable in the finger nails and is, I believe, a very reliable symptom. Unlike typhoid, the skin, where not cyanotic, is unduly pale. If the meninges are not involved the nervous symptoms are not very marked, being like those of typhoid in its early stages—i. e., apathy, headache, and slight wandering. In the second week the meningeal involvement is usually pronounced and severe delirium appears. The wasting, especially of the chest and muscles, is marked, as is the pallor, and the fever now becomes irregular and is accompanied by sweats. The course is usually from three to four weeks, but can be prolonged to many weeks, and Grancher believes that there can be an attenuated form running on for a long time.

The difficulties of diagnosis are such that probably the majority of cases are ascribed to typhoid, and, indeed, the attacks of "typhoid fever" in the beginning of chronic tuberculosis, of which one is often told in histories, were probably, in a certain proportion of the cases, acute tuberculosis which later became chronic; an ending, the possibility of which, while difficult to prove, can scarcely be doubted. The

Widal reaction, if positive, can exclude tuberculosis if we are sure the patient has not had typhoid in recent years, but its absence, unfortunately, does not justify us in considering the case tuberculous.

The demonstration of tubercles in the choroid (Litten) which can produce dimness of vision (Graefe) is, of course, diagnostic, as is the discovery of tubercle bacilli in the blood, if it can be made; and now that the advance of bacteriologic technic promises to render the discovery of the bacillus of tuberculosis and of typhoid in the blood more easy, it is justifiable to hope that we will have a reliable means of differentiating these two diseases.

When acute miliary tuberculosis develops, not apparently *de novo*, but in a patient suffering from chronic tuberculosis, the diagnosis is less difficult, and it need scarcely be noted that in doubtful cases the search for old foci must be very thorough, for in such cases it is apt to be mistaken for influenza. The temperature suddenly rises very high, with chills, but the development of dyspnea and cyanosis, and later of meningeal symptoms, may help to clear up our doubts.

At times in acute miliary tuberculosis such enormous numbers of bacilli enter the circulation at once as to overwhelm the patient, and to kill by toxemia before any histological evidences of the process have had time to form (Fraenkel), and in such cases death occurs in from one to two weeks, with signs of intense intoxication, combined with great dyspnea, cyanosis, and tachycardia; but unless we know the previous existence of tuberculosis in the case, diagnosis cannot be made. Such a case in my practice developed two days after a simple hemorrhage, and was marked by influenzalike joint and body pains, rapidly increasing dyspnea, the respiration toward the end reaching 52 to 62, intense cyanosis and a tachycardia of 144 to 160, along with renal (anuria) and meningeal symptoms, death occurring in six days.

The *bronchopulmonary* form usually begins with a not very diffused bronchitis showing isolated areas of catarrh of the fine tubes, recognized by fine crackles or fine moist râles, but with no breath changes, or, at most, feeble breathing. Percussion changes are absent. The sputum is scanty and glairy, though it can be rusty. Bacilli, unless an old chronic focus be present, are absent. The temperature is irregular, the dyspnea marked, and the pulse rapid. It is common in children, and can in them simulate a simple bronchopneumonia, and every child having this disease, when the resolution is delayed and dyspnea pronounced, should be closely watched.

In adults it is usually mistaken for grip, and, in the absence of bacilli in the sputum, only the final outcome can exclude tuberculosis—as in a case in my practice, where a primipara with an old arrested tuberculosis developed four weeks after delivery, and after recent expo-

sure to influenza, symptoms typical of acute miliary tuberculosis, fine crackles in the lungs, intermittent high fever (105° F.), and chills, a rapid pulse, and dyspnea, but no cyanosis. I felt very sure that the pregnancy had mobilized bacilli, but the gradual disappearance of the signs and symptoms in four weeks, and a return to previous health, showed that it had been a grippal infection. The cough is dry and hacking, but not severe; the fever very irregular, and at times hectic, with sweats, etc. The course is rapid, from three weeks to two months.

French authors have also pointed out a modification of this form, which they call "suffocative" (*tuberculose aigue suffocante*), marked by sudden dyspnea of great intensity, suggesting asthma, weak or absent breath sounds, sibilant râles, no expectoration, enormous tachycardia (180 to 200), rapid emaciation, and high fever, death occurring from exhaustion in two to three weeks.

A *pleural form* is also recognized, beginning either suddenly with effusion and high fever, or gradually. In the first case there is chill, fever, and pain; but, unlike a simple pleurisy, there are marked toxic symptoms, and it is apt to end suddenly in meningitis. The rapid course, great exhaustion and intoxication, and the brain symptoms must be relied on for diagnosis. The fact that the dyspnea is out of proportion to the amount of effusion, and the undue wasting, may assist in the diagnosis. The course is from five to six weeks.

Before turning our attention to the individual symptoms and signs of pulmonary tuberculosis, it need scarcely be noted that we must regard them as a whole and in their relation to each other, rather than individually, if we are to get a proper impression of the case, and that in the study of the symptoms we should never forget the sick individual as to whose needs the symptoms and signs are our guides.

Both prognostically and therapeutically, symptoms are of more value to the physician than signs. It is an everyday experience that a patient can present quite extensive physical signs while enjoying relatively good health and working efficiency; while at times a person with severe symptoms and who is in a serious condition may present signs which surprise us by their relative insignificance. Therefore, in estimating the chances of our patients, we should be careful not to fall into the common error of basing our opinion chiefly on the signs, or, in the diagnosis of a case, of neglecting symptoms such as hemoptysis, chronic cough, languor, etc., because marked physical signs cannot be demonstrated.

It is true that in diagnosis signs are of the greatest value, but even here they can only be properly studied in conjunction with symptoms, and diagnosis, after all, is only of value as it leads to a correct prognosis and a rational treatment, and for these, as noted, symptoms are

the determining factor. Hence we can see the great need of a very careful study of the history and the current symptoms. In this connection it is a great mistake for the physician to belittle or neglect symptoms noted by the patient without first carefully investigating them. While the neurotic can develop many and unimportant symptoms, it is not rare to have an intelligent patient notify us of feelings which we dismiss as unimportant but which the later course of the case proves to have been early, and had they been heeded and rightly valued, very useful warnings of impending hemorrhage, congestion, pleurisy, etc. Hence it is advisable to give careful attention to all reports of unusual sensations, and not to dismiss them from consideration too quickly.

Again, in the course of a recovering case of pulmonary tuberculosis, the symptoms disappear at a time when physical signs can still be easily found, and since the former are the only evidence the patient has of his sickness, he is apt, unless he is unusually carefully trained and taught, as soon as they cease to trouble him, to forget that he is a sick man, thus frequently leading to imprudences and relapses.

Finally, at the risk of repetition, let it be once more noted that the rational study of a case implies a consideration, not of any few prominent features, whether from the history, previous examination, or clinical study, but a broad-minded consideration of all and their correlation into a complete whole, so that we may get a broad and clear picture of one malady which we are called to treat. Only so will our results be a credit to ourselves and of benefit to our patients.

SUBJECTIVE SYMPTOMS

Fever.—Of the constitutional symptoms, fever occupies the most important place from a diagnostic and prognostic point of view, and as a guide to treatment. It gives one of the earliest evidences of the

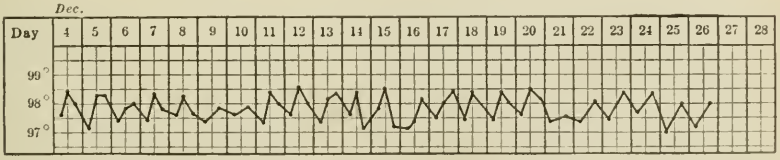


Fig. 24.—Stage I. Typical Moderately Subnormal Temperature. Marked neurasthenia. (Case G. E. B.)

activity of the bacillus, and while some have maintained that simple, uncomplicated tuberculosis is afebrile, the consensus of medical opinion is against such a contention. This view seems to be fully justified, not only because of the well-known effects of the injection of the products

of the bacillus into the human body, but also because of the elevations in temperature which so uniformly accompany increase in activity of the tuberculous process, and the falls which follow each decrease in activity.

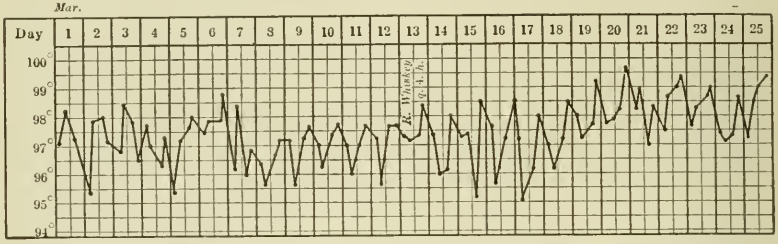


Fig. 25.—Stage I. Marked Subnormal Temperature in Young Woman of Very Poor Vitality. Note effect of moderate amounts of alcohol. (Case B. G.)

Technic of Measurements.—Temperature observations, to be of value in the diagnosis of tuberculosis and, although in a less degree, in the treatment, must be taken every two hours. The usual custom of taking the temperature three times a day, or only in the afternoon, is a bad one, because then important fluctuations are often missed. The patient can easily be taught to take his own temperature accurately, and it is better for the doctor to fear a mistake in diagnosis than to fear alarming a nervous patient.

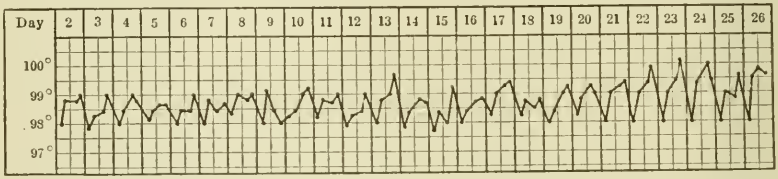


Fig. 26.—Stage II. Slowly Spreading and with Gradually Rising Fever. Progressing general dissemination. (Case J. C.)

It is very important also, in a disease in which a few tenths of a degree of variation in the temperature have so much significance, that we use a thermometer of whose accuracy we have a better evidence than the certificate of its maker. Experience has taught the writer that a large percentage of thermometers sold to physicians have errors greater than three tenths of a degree. At the same time the temperature curve must not be relied on exclusively to the neglect of other important data, for not rarely an unfavorable case has a very satisfactory temperature curve. Harris and Beale ('95) note that the individual idiosyncrasy must be taken into account; different people, under similar conditions, show very different febrile reactions to the same stimulus, and very wisely they say: "The absence of high temperature must not be regarded as

wholly a favorable symptom, if other symptoms of active disease are present."

The measurements, to be accurate, must be taken for a full five minutes, no matter how rapidly the thermometer registers, and outdoors in cold weather for eight, ten, or even fifteen minutes. In very cold weather the patient should come indoors to take the reading. An interesting study of this subject was made by Bluhm ('01), who showed the effect of the external temperature on that in the mouth. She noted that in the case of a patient with an occluded nose, who unconsciously from time to time opens his mouth to inhale the air, readings may be unreliable. She also found that the difference of temperature produced by the outdoor cold varied in different patients, but that the effect could be lessened by covering the face.

Some German writers (notably Walther, of Nordrach, and Penzoldt) have strongly recommended taking the rectal temperature be-

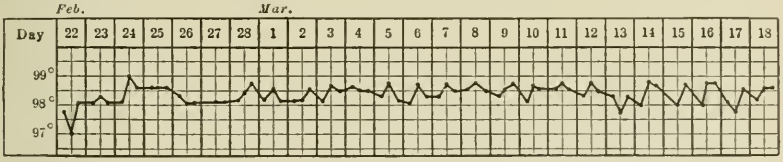


FIG. 27.—STAGE III. EXTENSIVE LESIONS WITH NORMAL TEMPERATURE. Temporarily no activity of process. (Case Mrs. M.)

cause it is more reliable, but the majority of clinicians prefer to take the mouth temperature. Such trials as the writer has made of the rectal method have led him to consider it unnecessary, in the large majority of cases, and this agrees with the conclusions of Schröder and Brühl ('02), who studied the subject carefully. If the temperature is taken long enough, the mouth readings, in my experience, have generally run parallel with those in the rectum and axilla; not as high as the former by about a half degree, nor as low as the latter by the same amount. Ostenfeld ('04), who uses rectal measurements, found 70 per cent of 250 cases had nearly parallel rectal and mouth temperature curves.

Against the procedure is not only the fact that the manipulations are most disagreeable, and no doctor can afford to disregard the susceptibilities of his patients, but, much more, that it necessitates the patient's going to his room each time, which, if two-hourly observations are made, is extremely inconvenient, and for ordinary use its defects are not outbalanced by sufficient compensating advantages. Braine-Hartwell ('01), who is an enthusiastic advocate of the rectal method, considers it essential to accuracy, and gives temperature curves showing great variations between the mouth and rectum, as does Saug-

man. In the case of bedridden patients, or in those where we suspect a temperature which the mouth does not reveal, or in afebrile cases in which exercise has a bad physical effect not explained by the thermometer, it is wise to use this method long enough to satisfy oneself that the mouth temperature is not deceptive. In the large majority of cases mouth readings can safely be relied on to guide us in the study of patients. In doubtful cases it may at times be necessary, as noted, to resort to rectal measurements as a control of mouth readings, as the former are less affected by external influences and are more absolutely accurate. Despite the advocacy of rectal measurements by a few well-known authorities, they have not won general acceptance by the special workers in this field. So good an authority as Turban is satisfied with mouth readings in most cases.

Course of the Fever.—While many attempts have been made to distinguish a temperature curve typical for tuberculosis, such as exists for typhoid, the polymorphism of the disease renders this impossible.

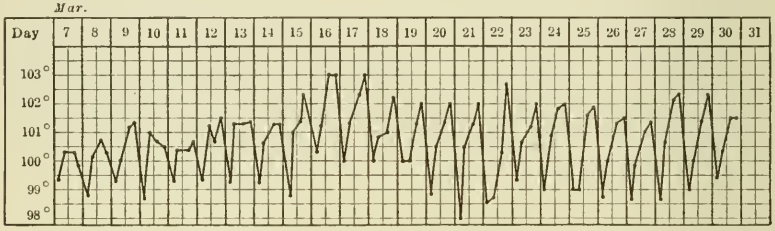


Fig. 28.—Stage III. Active Spreading Process in Both Lungs and Commencing Cavity Formation. Continual fever. (Case C.)

The temperature may be absent, intermittent, remittent, or even, though rarely, continuous. We may have a scarcely recognizable intermittent fever with a normal morning or, more generally, subnormal temperature, and a very slight evening rise to 99.4° F., or a little later a more pronounced intermittent temperature with an evening rise to 100° F. or over. A remittent temperature with a morning temperature of 99° F. to 100° F. is often seen, though if the temperature is taken as early as seven o'clock it will still be found to be subnormal. In the evening such cases rise to 101° F., or in more severe cases as high as 103° or 104° F., though the average case of tuberculosis, unless far advanced, will not generally show a temperature higher than 103° F., except during acute exacerbations.

The hectic temperature is associated with the late stages of tuberculosis and extensive ulcerating cavities, with profuse purulent sputum, often showing streptococci. There is a subnormal morning temperature, as low as 96° F. or 95° F. plus, and with or without an early

afternoon chill and a subsequent rise to 102° to 105° F. The study of the temperature in early cases is of great value, and, as has been stated, in no other disease do such relatively slight differences of temperature possess such importance.

Most of the writers on the subject, with the exception of C. J. B. Williams, have not laid sufficient weight on the significance of morn-

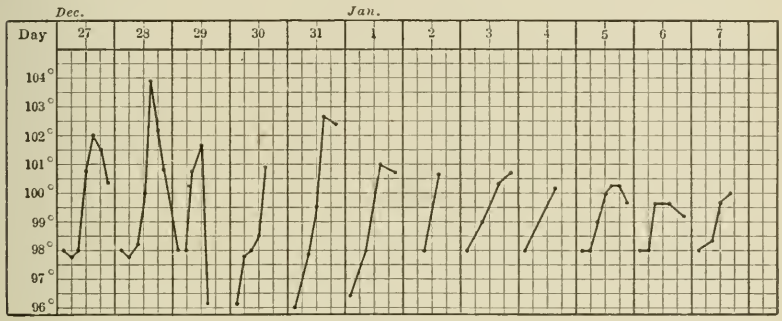


Fig. 29.

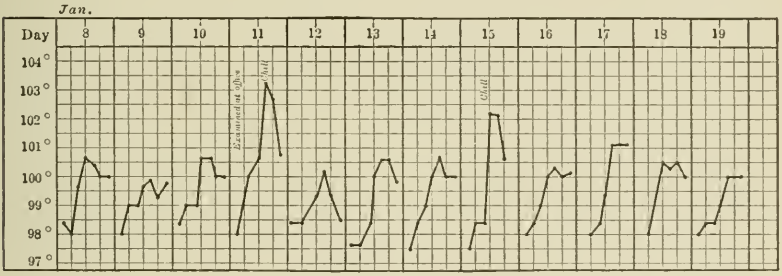


Fig. 30.

Figs. 29 and 30.—Non-resolving Tuberculous Pneumonia with Chills, Sweats, Hectic Fever, and Rapid Breaking Down of Lung, with Mixed Infection. (Case W. G.)

ing subnormal temperatures in such cases. In the experience of the writer, who has made two-hourly temperature observations in all cases for a month at least, and often for longer periods of time, for years, the morning temperature in tuberculosis is rarely up to normal, and this subnormal morning temperature is of real diagnostic value. Often before any evening rise can be found, the temperature on waking is 97° F. or under, which, however, soon becomes normal, so that if the first temperature is not taken early enough, this subnormal temperature will be overlooked.

As the case goes on to arrest or to apparent cure, the evening hyperthermia disappears long before the patient loses his morning hypo-

thermia. The evening rise in early cases is rarely more than a few tenths of a degree, and while Vierordt gives the range of normal temperature as from 97.8° to 99.6° F., a persistent evening rise to 99.2° F. can be considered as fever, providing the digestive tract is in order. A morning temperature below 97.8° can be considered subnormal, except in very cold weather. Turban ('99) considers a temperature of 98.9° F. the limit of normal mouth temperature, and a temperature of 99.3° F., with the patient at rest, if frequently recurring, as fever. In such early cases there is generally a subnormal temperature at 7 or 8 A.M., before the patient leaves his bed, which rises to normal at 9 A.M., remaining normal until after midday (though a little later the rise begins at 12 M., or even earlier), from which time it rises, reaching its maximum somewhere between 2 and 6 P.M., generally about 4 P.M., and falling back to normal very quickly in early cases, more gradually in more severe cases. Unless a two-hourly temperature record is taken, this fluctuation is very easily overlooked.

Here it should be noted, however, that if a 1 P.M. dinner is taken or a heavy lunch, there will be a postprandial rise in temperature within fifteen minutes or a half hour after eating, higher than the general average, and which does not give a true idea of the real two-o'clock temperature. This postprandial rise is normal in health, but is magnified in tuberculosis, so that a heavy eater or a dyspeptic will have the highest temperature of the day between 2 and 3 P.M., after his midday meal, but this slight postprandial rise, as already noted, is in ordinary cases separated from the real maximum, which usually comes later. In view of this fact, slight after-dinner rises have of course less value than those coming at four or six o'clock, and it should also not be forgotten that cases of anemia (as noted by Papillon) show such a rise.

In somewhat more advanced cases the temperature begins to rise about twelve o'clock, rises gradually to its maximum, and falls gradually, reaching normal about eight or ten o'clock at night, and falling steadily after that, to reach the lowest point at about 3 A.M. Certain cases, however, and they are generally bad ones, have their maximum in the night, and at times it may be necessary for diagnostic purposes to wake patients at intervals for a night or two in order to find this out.

A flushing of the face after meals is often noted in tuberculous patients, even before a temperature rise can be discovered, and this at times is a useful hint.

All tuberculous patients are easily affected by both physical and mental disturbances, such as overexcitement, overexercise, grief, anger, worry, all of which make their mark on the temperature curves of these sensitive organizations. In apparently afebrile cases one can disclose

an otherwise hidden temperature by ordering a long walk. In some cases the temperature is depressed.

Again, a patient who is improving will lose his evening rise long before his morning subnormal temperature, which persists until normal vitality has been restored, and no patient should be considered as being cured until this subnormal temperature is lost. Even after a return to normal and an arrest of the process the temperature is apt for some time to be easily affected by nervous influences.

The graphic curves of the majority of women patients show a rise of temperature just preceding and during the first two days of the menstrual period, and when, in a woman, the temperature is normal at ordinary times, it is wise to wait for the next menstrual period before making a final decision. Except in the case of very excitable people, there is no subjective sensation of temperature in this stage, and even considerably later, so that these patients will report various symptoms which make certain the presence of increased temperature long before the time when the patients themselves have noted it. Neurotic patients notice fever much earlier than others, and if they know that fever is being sought for they will often note flushed cheeks and feel feverish when the thermometer shows no rise of temperature.

It must never be forgotten, in studying the temperature of a suspicious case, that incipient cases often show periods of normal temperature, followed by rises above the normal, so that a diagnostic study of temperature, if negative at first, should be continued for two weeks or a month if certainty is desired. As the disease progresses and evident consolidation appears, the evening temperature rises to about 100° F., or more rarely to 101° F., the morning temperature still being subnormal, though it tends to reach normal at a progressively earlier hour.

The course of the temperature is also marked by occasional more active rises as new areas of involvement manifest themselves. This irregularity of course is very typical of the temperature of tuberculosis, and while at times the curve remains unchanged for months, it is not the rule, the graphic curve of the average case showing very beautifully, by the perturbations of its course, the various harmful influences which affect the patient.

The graphic curve is a very valuable aid in the study of the patient, and should be noted in all cases for the first few weeks at least, and in some cases for a longer time. As a general rule, a *poussée de congestion*, as the French term the exacerbations so typical of the disease, does not come on suddenly, but is preceded by two or three days of slowly rising temperature and accelerating pulse before any other symptoms show themselves. This gives the doctor an invaluable oppor-

tunity to attack and cut short the congestion before it gets beyond control.

Digestive disturbances, so common in tuberculosis, generally produce a sudden and much higher rise, which usually begins earlier in the day, with symptoms of gastric discomfort. The prompt removal of such complaints by means of calomel and starvation lays bare their nature. Some cases of temperature of moderate degree but great obstinacy disappear completely on the discovery and correction of gastric dilatation and stasis, and such cases demonstrate the close and important relation of stomach conditions to the course of tuberculosis.

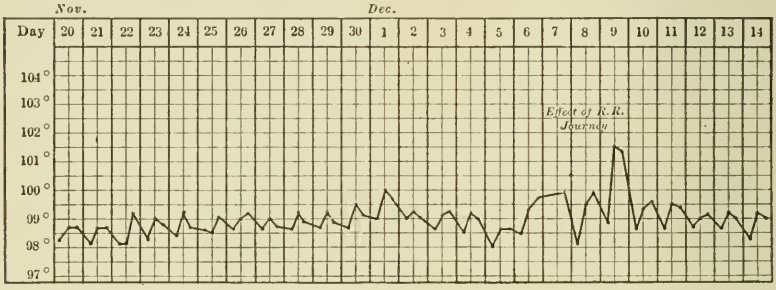


Fig. 31.

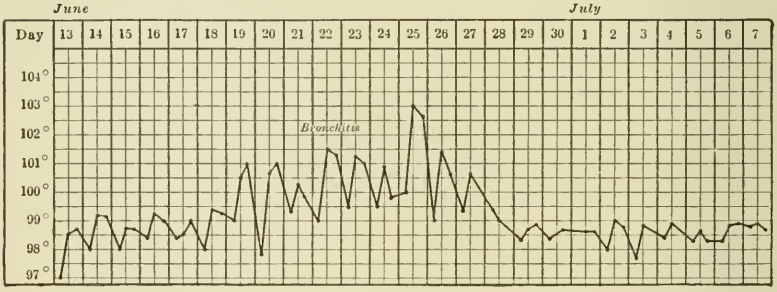


Fig. 32.

Figs. 31 and 32.—Stage III. Inactive, Showing Effect of Overexertion (Railroad Journey) and of an Acute Bronchitis. (Case L. R.)

Even acute pneumonic attacks are generally preceded by a slow rise in temperature before the sudden ascent in temperature and chill which usher in the actual attack. Ischiorectal abscesses, for some time before they trouble the patient sufficiently to draw attention to the seat of the trouble, affect the temperature considerably. In a case seen by the writer, an afternoon temperature of 100° to 100.8° F. persisted for several weeks before the patient felt any pain or inconvenience in the rectum, but when this appeared and a small abscess containing not more than two drachms of pus was evacuated, the temperature dropped to

nearly normal and has remained there ever since. Therefore, it is necessary to make sure that the increased temperature is not due to extrapulmonary causes before it is ascribed to the lung condition. When, in a case of tuberculosis with fairly extensive lesions, there is a persistent low temperature with symptoms more mild than the extent

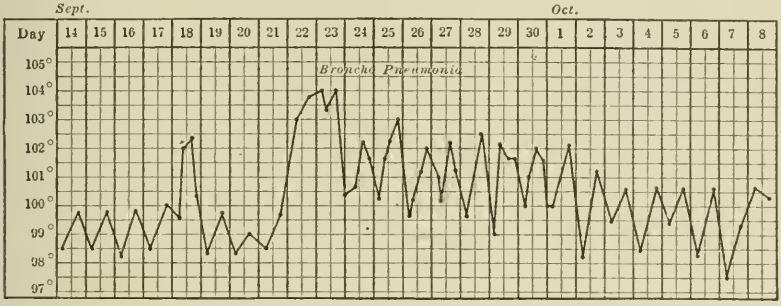


FIG. 33.—STAGE II. SHOWING EFFECT OF INTERCURRENT BRONCHOPNEUMONIA ON FEVER CURVE. Fall by lysis and recovery. Patient made complete recovery. (Case C. M. C.)

of the trouble would seem to justify, it should always suggest the possibly fibroid nature of the case, such a temperature record being very characteristic of this type of cases.

As the process reaches the third stage, with extreme infiltration and destruction of tissue, with excavation, the temperature, as a rule, ranges from 101° F. up, the rise coming on as early as ten or eleven o'clock in the morning, or not later than midday, and lasting until quite late at night. This long-continued fever naturally severely affects the patient's constitution. Softening of involved areas is generally accompanied by high and obstinate temperatures which will not fall until the necrotic area is sufficiently softened to be expectorated.

Cavities whose contents tend to collect and dam up instead of being expectorated freely, will also cause rises of temperature, though not being accompanied by inflammation the rise is not generally as high as is that caused by softening of lung tissue, but is rather of a hectic type, and it falls when the pus is expectorated. These are the cases in which posture aiming at emptying such ill-draining spaces, is so effective.

When excavation is extensive and drainage is poor, an irregular remittent or hectic type of fever appears, marked by a very low subnormal morning temperature and high but irregular afternoon rises, often preceded by chills and followed by sweats, and associated with rapid emaciation. There is generally a profuse purulent expectoration which, even when properly collected and washed, shows swarms of streptococci. This

is generally considered as justifying a diagnosis of mixed infection—that is, the existence and pathogenic activity in the lung of other organisms along with the tubercle bacillus, usually the streptococcus.

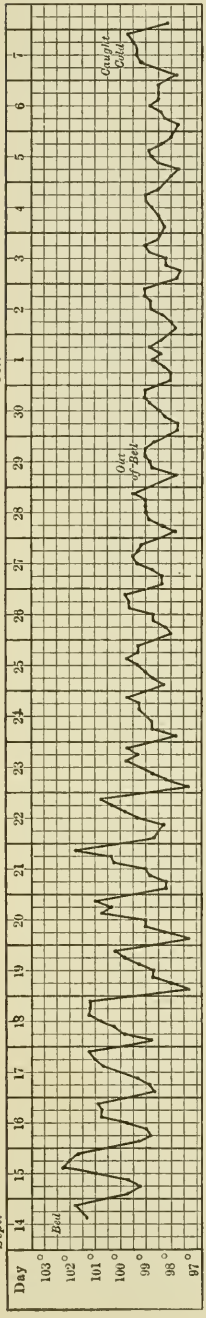


Fig. 34.—Stage III. Shows Effect of Absolute Rest in Bed on the Fever in a Patient who had been Exercising Freely and Who Also Suffered from a Severe Chronic Parenchymatous Nephritis. Patient for a considerable time returned to normal temperatures and made excellent progress. (Case G. S.)

Many excellent authorities deny the existence of this condition and have brought forward considerable experimental proof against mixed infection, but the clinical evidence, which, after all, should have the greater weight in coming to a decision in this matter, seems to justify the belief that the symptoms spoken of are not produced by the tubercle bacillus alone, but demand the coöperation of pyogenic microörganisms.

In these late cases there may be in rare instances a *typus inversus*, in which the night and early morning temperature is high, and the midday and evening temperature low. Its presence is always ominous. The writer has noted in a few cases of hectic fever that any attempt to lower the temperature by means of coal-tar antipyretics produces such a *typus inversus*, the cause of the fever being so active that when it is repressed at the usual hour it reappears at another.

In old cases, with moderate activity and large, relatively dry cavities, with tendency to fibrosis, it is not at all rare to see a normal or nearly normal temperature present for months, and while not improving the ultimate outlook, it is of benefit in so far as it allows of better nutrition and rest, and adds to the patient's comfort. A double or triple rise of temperature in twenty-four hours, punctuated with sweats, occasionally occurs. It is a bad prognostic sign.

A temperature remaining persistently above 101° F., despite absolute rest in bed in the fresh air and proper dieting, is a uniformly unfavorable sign, speaking for

wide dissemination and a rapid spread of the disease, and unless the system can be given strength enough to conquer it, a downward course and a fatal termination may be anticipated.

Not infrequently the patient, despite rest in bed in the fresh air, runs a persistent temperature for weeks. When these patients are gotten out of bed and allowed to sit up a little and to walk around, the temperature, contrary to expectation, gradually drops to normal. The writer has noted this in numerous cases, and can vouch for its accuracy, although he cannot explain it, unless on the ground that the temperature is due to a disordered digestion, which erect posture and a less sedentary life improved. Except in old, dry, fibroid cavity cases, where, as noted above, there may be a good temperature record with a hopeless outlook, a gradual fall of temperature is almost always evidence of a lessened activity of the process in the lung and an improved prognosis.

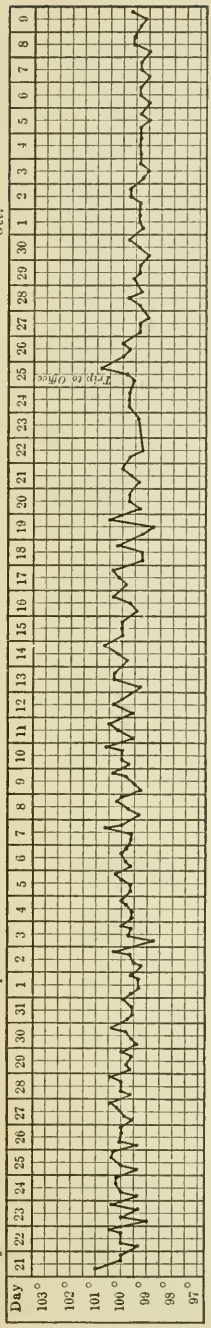
In advanced cases there may at times be sudden drops in temperature. These speak either for the approach of the end or for shock accompanying the occurrence of a pneumothorax.

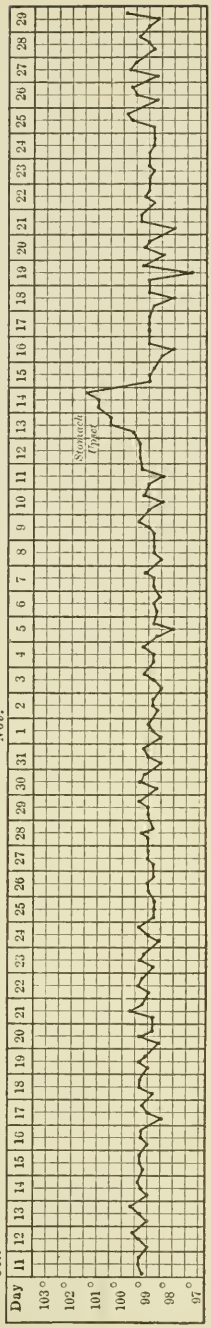
The bad effect of fever on the patient's digestion is so great that everything possible should be done to control it. The patient with a high temperature has neither appetite nor digestive ability. After he eats, his temperature is greatly increased, and it is necessary to arrange meals so that the heaviest meal is taken at the time of the least fever. In such cases coal-tar antipyretics may be used, if necessary. In advanced cases the morning appetite is apt to be wanting, and these patients should eat late in the evening, after the fever falls.

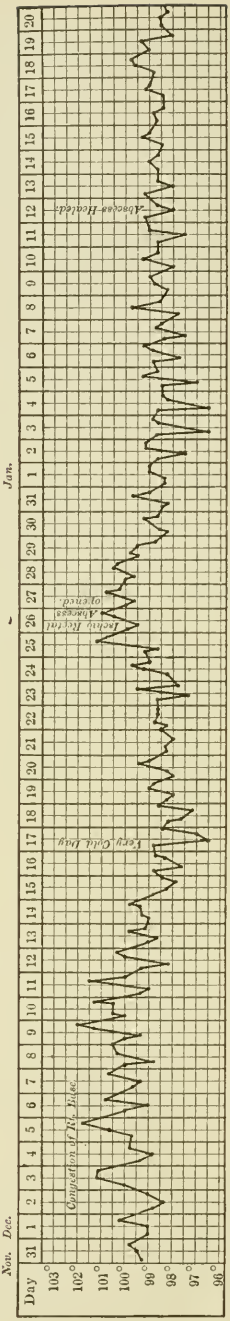
Continuous fever is rare in tuberculosis, occurring only during the existence of complications or in acute cases. Remittent fever is the rule. It is unfortunate that so frequently fever is initiated by a chill and followed by sweats, and is intermittent, because this often gives rise to a diagnosis of malaria, which may cause the loss of much precious time. In view of this, it need hardly be said that such symptoms, even if appearing in a malarial region, should suggest not simply a search for the parasite of malaria in the blood but a careful examination of the lungs.

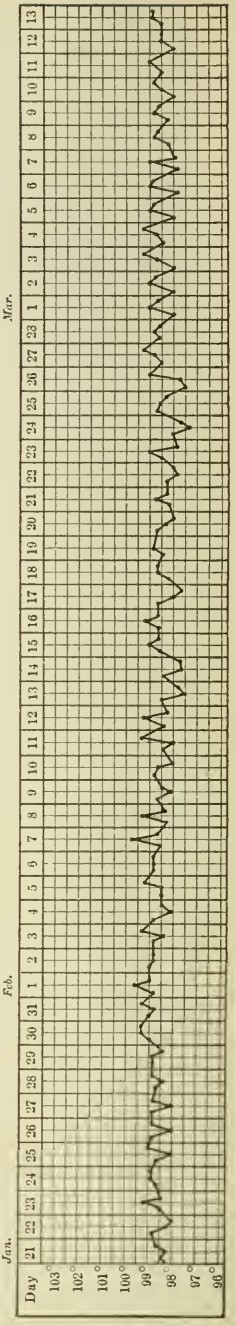
Chills.—In the incipiency of chronic tuberculosis, chills are rare, save a slight temporary chilliness, which, if inquired for, may be discovered.

As a rule, it is only in acute pneumonic phthisis, or in acute miliary tuberculosis, that there occur pronounced chills in the beginning. In the second stage they are also rare, except when they usher in a congestion or some complication. In the third stage, especially if severe


Day
103°
102°
101°
100°
99°
98°
97°
Trip to Office.


Oct.
Nov.
Day
103°
102°
101°
100°
99°
98°
97°
Stomach Upset


Nov. Dec.
Jan.
Day
103°
102°
101°
100°
99°
98°
97°
96°
Congestion of Rt. Base.
Very Cold Day
Ischio Rectal Abscess opened.
Abscess Healed.


Jan.
Feb.
Mar.
Day
103°
102°
101°
100°
99°
98°
97°
96°

mixed infections exist, they are common, generally occurring early in the afternoon and preceding high rises of temperature.

Hoarseness.—In delicate people, who are apt later to develop tuberculosis, the voice is weak or it has a tendency to become husky on changes of weather.

In a few early cases there is pronounced hoarseness, due either to a slight adductor paralysis from gland pressure on the recurrent nerve or a slight catarrh, and Schaffer ('83) considers this an early symptom; but slight hoarseness can be caused by so many other conditions that, while it justifies a careful examination of the whole respiratory tract, it cannot be considered diagnostic. In more advanced cases hoarseness from a simple catarrh is often seen, but if it persists it strongly suggests tuberculous laryngitis. (See Larynx.)

Sweats.—While sweats are a very common symptom in tuberculosis, this does not apply to the early stages of the disease, where they are not often seen, although a tendency to undue moisture of the skin of the forehead, neck, chest, and abdomen on slight exertion, or if the room is rather warm, is often noted. Profuse sweats in early cases, as reported by such a good authority as Sokolowski ('06), the writer has not seen. The nervous strain of a physical examination is apt to cause profuse sweating in the axillæ, but, though it has been classed as such by some, this cannot be called a symptom of tuberculosis as it may occur in any nervous individual.

In the second stage sweats are a common and typical symptom. They generally occur in the night, usually shortly after going to sleep, and are often repeated again in the early morning; but they may occur at other times, especially after overexertion or if the patient dozes in his chair. They are closely associated with the fever, and I have not known them to occur in really afebrile cases, but, unlike the sweats of malaria and the acute infections, they do not promptly follow on the fall of temperature in every case, although the night sweat generally does so.

In this stage sweats are rarely profuse or obstinate, and disappear with few exceptions without any especial medication shortly after the beginning of an outdoor rest life and proper hygiene. So generally is this true that the sweats in the second stage rarely need cause any anxiety, and one may count almost with certainty, on their ceasing within one, or at most two, weeks of the commencement of an outdoor rest cure.

In these cases the patient goes to bed feeling well, and on arising next morning finds his night clothes moistened around his neck and chest, but he is not generally disturbed by the sweat unless it is quite profuse. If it is profuse, he is awakened shortly after going to sleep

by a "gone" sensation, to find his night clothing wringing wet. After a change of clothing he falls to sleep again, to be awakened in the early morning by a repetition of this occurrence. Patients very soon learn that heavy bedding favors sweats, as does free water drinking or hot drinks, and in light cases proper attention to these causes is at times sufficient to prevent sweats.

In the third stage cases the sweats form a very serious and troublesome feature of the case, exhausting the strength of the patient and producing the greatest discomfort. Such patients soak the sheets several times a night, and their sleep is greatly disturbed, and even in the daytime, if they sleep, the sweats appear. These "colliquative sweats" are most obstinate and often fail to yield to any treatment.

The view of Cornet ('07), who ascribes the sweats to the action of a toxin of the tubercle bacillus, or other bacteria on the sweat or heat regulative centers, is now generally accepted.

While many excellent authorities deny that the various pus organisms play any part in the symptomatology of tuberculosis, the clinical picture in the late stages is so similar to that of septic infections that it is difficult to think that the streptococcus or other pus organisms have not some part in producing the sweats of this stage. By no means, however, do all advanced cases sweat: fibroid cases rarely present this symptom unless there are present secreting cavities.

Languor.—There are few early symptoms of tuberculosis more suggestive than languor, yet none is so often ascribed to other causes, the undue weariness which marks the beginning of so many cases being taken for anything rather than tuberculosis. In a majority of the writer's cases it was the first symptom noted by the patient, and persistent weariness should, of itself, be a sufficient reason for the most careful examination of a patient's lungs. To those who have not experienced it, it is difficult to describe the utter weariness that such patients feel, without any apparent reason, and chiefly in the afternoon, when the temperature is rising; but it is often present when no temperature is suspected.

The whole body seems filled with "tiredness"; even to breathe is an effort, and if the patient lies down to rest, weariness seems to run through his limbs. They ache with fatigue and seem to pin him to the bed. Later in the evening this feeling passes off and the patient often feels very well. On waking, a heretofore active man will find himself not rested or refreshed and with no ambition for work, and many such a one has feared he was getting lazy or has taken to bracing himself with alcoholics, or has had a diagnosis of neurasthenia made on account of it.

This weariness can often be overcome by taking food between meals

or at the time when the fatigue comes on, but it has not any connection with the anorexia of early tuberculosis, being a distinct toxemia.

Later in the disease, possibly because the system has accustomed itself to the effect of the intoxication, this symptom becomes less marked, and nothing is more astonishing than the activity and obliviousness to fatigue of the tuberculous patient who has considerable trouble and marked fever. In the late stages weariness is again present, but it is then due to extreme tissue waste and inadequate nutrition.

Emaciation.—Loss of weight has from the earliest times been one of the symptoms which has chiefly attracted attention, as is shown by the name "phthisis," from the Greek φθίσις (a wasting away). It frequently appears quite early, but is not generally present in the incipient stage, though a gradual loss of weight, without evident reason should, like languor, arouse suspicion as to the condition of the lungs. When the process becomes sufficiently pronounced to give evident signs of softening, it is practically never absent in an untreated case, the exceptions being so unusual as only to prove the rule, while it is uniformly and progressively present in all severe cases, and goes hand in hand with the advance of the trouble, affecting not only the muscles and fat, but every organ of the body.

On the other hand, a gain in weight has long been recognized as one of the most favorable prognostic signs. The patient who is steadily increasing in avoirdupois is almost always improving in his pulmonary condition, though temporary gains, quickly made, are of little significance.

L. Brown, in a careful study of the weight of the patients of the Adirondack Cottage Sanatorium ('03) says: "A regular, constant, uninterrupted gain of weight continued for two months is of favorable prognostic import, but the gain of a few pounds is not a sure sign of improvement."

Loss of weight, in the beginning, is probably of toxic origin, but later it is closely related to the fever and the anorexia, and generally, except in hopelessly advanced cases, or where intestinal involvement exists, disappears to a great extent when the temperature falls and when the appetite is fully restored. However, it must never be forgotten that some patients with large appetites continue to lose weight. In addition to a decreased intake of food there seems to be a greatly lowered absorptive power in the intestinal canal, possibly related to that congenital narrowing of the lymph channels which has been claimed to exist in this disease by some authors.

People with constitutionally poor weight-gaining ability, as well as those with habitually poor appetites, are unduly prone to develop tuberculosis, possibly owing to habitual under-nourishment of the cells and

consequent lowering of their resisting power. The dyspepsia so common in these cases should also not be overlooked, as its removal often affects the weight favorably. As has been said, however, the loss of weight in the early stages is probably toxic. Cornet, who is a great believer in the effects of the poisons of the bacillus on the body, recalls the well-known experiments in which the injection of cultures of the dead bacilli into animals has produced marasmus.

The loss of weight is apt to show itself first around the trunk, especially in women patients. In the early stage, at least, it is not apt to affect the face, so that the physician may be deceived as to the patient's real nutrition, unless he inspects the thorax and abdomen. Regained flesh is first noted on the abdomen, chest, and hips.

In advanced cases the high fever, with the accompanying tissue waste, added to the decreased tissue formation, produces extreme degrees of emaciation, with great wasting of the muscles. Here we get the prominent cheek bones and nose, with the dry, thin, branny skin drawn tightly over the bony prominences, and sinking into the hollows between, which for centuries has made the graphic term "consumption" a terror to layman and physician alike. In arrested cases the patient, even when he has regained his strength and efficiency, is very apt never to return completely to his previous normal weight, but always to run a few pounds below. To this rule there are many exceptions, certain patients after a climatic and hygienic cure reaching and maintaining a weight never enjoyed before, and we are justified in considering such cases unusually favorable.

The chief gains in weight are made in the winter months, most favorable cases (in Asheville) gaining from October to April or May, and falling off to a moderate degree during the summer, to recommence gaining again in October. Berger ('05), in the Basel Sanatorium at Davos, found that women gained more slowly than men, and that people between thirty and forty were the best weight gainers.

The total weight lost in bad cases is given by Ruehle ('87) as from one third to one quarter of the normal weight, a loss which Chossat found sufficient to kill dogs, but coming on gradually in phthisis, it is tolerated remarkably well. While patients will at times gain weight very rapidly for a few weeks, even up to one pound a day, this is unusual, and it is more usual to find cases gain from half a pound to two pounds a week in the winter season and less in summer.

In the first weeks or months of a hygienic cure the patient, if doing well, generally gains rapidly, often putting on one or two or even more pounds a week for a number of weeks, but as he approaches his normal weight the rapidity of gain slows down, and when he passes this point, further gains are usually at a rate of one quarter or one half pound

a week. Intercurrent disease stops weight-gaining, but if transient, and if the case is a favorable one, gain of weight will begin again after recovery from the disease.

Patients who indulge in alcoholics will generally put on weight rather rapidly, which is, perhaps, one of the reasons alcohol has been so much used in this disease, but, unlike weight normally gained, it is not accompanied by gain in strength; the patients get "puffy" and "flabby," and the general condition is not improved but injured. Finally, it should be noted that each patient's weight should be studied in relation to his height, as in the tables used by insurance companies, and, according to Papillon ('97), also in its relation to the thoracic perimeter.

Anorexia.—Anorexia, while generally classed as a gastric symptom, is more correctly considered as a constitutional one, arising at first more from the toxemia incidental to the disease than from the condition of the stomach itself. This symptom is one of the very earliest, and is apt to manifest itself first rather as a fastidiousness as to food than as a real disinclination to eat. Nothing is cooked quite right or tastes quite as it should, but before long this runs into a real lack of appetite.

Many patients for years have been light, fickle, "finicky" eaters, so that we can be in doubt as to whether the symptom is a result or a cause of the trouble. Many others have always eaten a poor breakfast but a good dinner and supper, and, in the writer's experience, anorexia, when it first manifests itself in tuberculosis, is apt to affect the morning appetite chiefly. It is by no means an index of poor digestive power, and when such cases force their appetites beyond their desire, though not beyond a reasonable amount of food, they often digest excellently and fatten. The same has frequently been noted with patients on gavage, or forced feeding.

The effect in this stage of the disease of fresh air and outdoor life, with the consequent increased oxygenation of the blood, is often most remarkable, and we are justified in feeling anxiety as to a patient who, under such conditions, fails to develop a desire for food. In moderately advanced cases we find at times very pronounced anorexia, the patient is disgusted by food even to the point of vomiting at the sight of it, and can force it down his throat only with difficulty. More commonly, however, there is a moderate desire for food, but the first few mouthfuls bring a sense of repletion, and the patient thinks he can eat no more. These are the cases where it is necessary to compel the patient to chew and swallow food against his will. Whatever the cause of the anorexia in early and moderately advanced cases, in the third stage it can unquestionably be ascribed chiefly to the high temperature, with its resultant anachlorhydria, although Müller ('04) denies the latter.

A patient in this stage, who may have a very good breakfast appetite, will by midday, and from that time until the temperature falls again, have no desire for food, partly due to his fear, bred of experience, that eating will send up his temperature. When later in the evening the temperature has fallen, these patients will often be able to take food with some relish, and it will sometimes be necessary to cut down the amount of food during the fever hours to a minimum and push it at other times. In late cases distaste for food is sometimes due to dysphagia caused by a tuberculous laryngitis.

The bulimia seen in some cases of tuberculous enteritis, with glandular involvement, should here be noted. So characteristic is this ravenous appetite in this condition, that it has great diagnostic importance. While there are no abnormal cravings, there is often an aversion for just those foods which are best—i. e., meats and fats. Such a dislike is very common and very difficult to overcome.

A perfectly normal appetite is often found, but only in those cases with the best outlook. It is an admirable prognostic sign.

Dyspnea.—In pulmonary tuberculosis dyspnea is of two kinds, of widely differing import. In acute miliary tuberculosis, or in the beginning of acute phthisis, dyspnea is an early symptom, and is probably due to irritation of the vagus terminals by the innumerable tubercles and to the physical effect of their presence on the respiratory capacity of the lungs, as well as to the systemic effect of the toxins. In this form it is usually accompanied by cyanosis.

In the beginning of the more chronic form of tuberculosis it is not found, although some authors consider it an early symptom. Blancard ('07) quotes Arthaud, who describes a peculiarly dyspneic facies which he thinks diagnostic of tuberculosis: "The characteristic thing in the tuberculous facies, even at the beginning of the period of invasion, is the permanent spasm of the respiratory apparatus which gives the face that expression of suffering which one notices with the last symptoms in hopeless cases. The dilatation of the nostrils, accompanied or not by emaciation of the face, should cause us always to suspect tuberculosis."

In his own early cases the writer has noted on his charts the alæ of the nose and the facies in all patients, and has not been able to verify this observation. Some shortness of breath on exertion or on talking will often be complained of, or noted by the physician, but it is not sufficiently marked to have great diagnostic value. The dyspnea of moderately advanced cases is chiefly noted on exertion, and while it can be increased by cough, eating, or fever, it is always relieved by rest. It is probably due at this time to lessened lung area, or possibly, as Fox suggests, to the lessened amount of blood to carry on the systemic

respiration, though as it is found at times in the full-blooded, this would seem doubtful, but his added explanation that it is due to compensatory emphysema seems improbable. It can also, however, be produced in a severe form by the pressure of enlarged bronchial glands on the pneumogastric nerve, and in the neurotic, like all other symptoms, it will be found unduly magnified, though it is probably not of nervous origin as some teach.

The formation of much fibroid tissue in the lungs is responsible for the development of a very slow and gradually increasing dyspnea, which can be so marked as even to persist during rest; and a gradually increasing shortness of breath in a patient otherwise doing well, should strongly suggest the presence of marked and extensive fibrosis. An extensive old pleurisy can so bind down the lungs as to cause dyspnea.

The sudden development of dyspnea at this stage is generally of serious import, and speaks for extension of the area of involvement or possibly for pleuritic effusion. Apparently causeless dyspnea, in cases without marked limitation of respiratory area, should always excite suspicion of an acute, or at least a very general, dissemination. It is found quite frequently in those subacute cases which present the signs of a miliary tuberculosis, but which run a relatively slow but uniformly fatal course.

A case in point seen by the writer was that of a girl of twenty-four, with tuberculosis of a relatively slow course, and with no sign of extensive infiltration, but rather of disseminated tubercles. There was a pronounced dyspnea of obscure origin, and the bad prognosis based largely on this symptom was borne out by the subsequent history. In some cases where the dyspnea is not noted in the daytime there are severe asthma-like attacks in the night, but these generally yield to potassium iodid. They were probably ordinary cases of asthma in tuberculous subjects.

In advanced cases the degree of dyspnea, in spite of the extensive destruction of lung tissue, is astonishingly small; except on exertion, the dyspnea of tuberculosis, as West notes ('02), bearing a much closer relation to the rate of development of the disease than to its extent. Thus the gradual development of the process in tuberculosis gives Nature time to bring into play her wonderful adaptability to new conditions, and it is only when such time is not allowed, as in rapid disseminations, sudden pleural effusions, or more especially in pneumothorax, that dyspnea can be excessive, agonizing, and at times fatal. When the moderate dyspnea of third-stage cases is spoken of, it must be recalled that such cases are usually at rest; when from their financial condition they are obliged to keep up physical exertion, dyspnea can be a very painful feature and one that cannot be relieved.

Cyanosis.—Cyanosis is not ordinarily seen in the chronic forms of pulmonary tuberculosis, though some degree of cyanosis of the finger tips and of the face is found in advanced cases or where there is rapid dissemination, and it is also to be seen in the clubbed fingers. In acute miliary cases, however, it is an early and alarming symptom.

The Circulatory System.—The circulatory system very early in tuberculosis undergoes modifications which affect both the pulse-rate and the blood-pressure. Tachycardia appears very early in the disease, and, indeed, often exists for a considerable time before any pulmonary lesion can be discovered, so that those who have assumed the existence of a "pretuberculous state" have picked this out as one of its most marked symptoms. While not admitting the existence of such a state, the active presence of the bacillus in the body before it can be definitely diagnosed, which probably corresponds to what its advocates call the "pretuberculous state," can undoubtedly be strongly suspected when, in a patient whose normal rate is known, there is a persistent or even intermittent rise in rate which cannot be accounted for otherwise.

That this tachycardia, occurring so early, can be explained on any other assumption than the action of the poison of the germ does not seem possible, though it has also been ascribed to atrophy of the heart, and while the pressure of enlarged bronchial glands on the vagus can produce severe tachycardia, such enlargement is by no means as common or as early as is the symptom. It can occur long before any rise in temperature is evident. It may at first be paroxysmal and brought on by excitement or by food. Wells has noted that the pulse of the tuberculous, unlike that of the normal man, is not notably increased in rate by change of position from lying down or sitting to standing, and Papillon and other French writers have made much of this symptom; but the contrary is reported by Ruehle and Thomayer ('04), and in investigating the matter the writer has found it as often absent as present.

When the disease becomes evident the pulse is almost always increased in rapidity, generally running from 85 to 110 in average cases, but in severe cases from 110 to 120, and at times even higher. A persistently fast pulse of over 110 is a symptom of serious import, unless it yields to rest and treatment. On the other hand, a lessening of the pulse-rate is most encouraging, and is an excellent sign of lessening trouble, with decreased discharge of toxins into the blood, and speaks for increase of vitality and recuperative power; while the persistence of a nearly normal pulse-rate, despite demonstrable lesions, is probably the best index of a robust constitution and good fighting power. In old third-stage cases a rapid pulse is never absent, save toward the end, when a slow pulse and the appearance of intermissions speak for a failing heart; but at this

stage the tachycardia is doubtless due largely to the fever. In an arrested case one cannot feel safe as to the continued progress of the patient as long as the pulse-rate remains high—over 90 in men or 95 in women; but rarely does the pulse return entirely to its former normal rate, however otherwise satisfactory the results may be. Tachycardia cannot be assumed to exist until it has been verified at many different times, the excitement caused by the physician's presence tending to produce a temporary acceleration, and when the patient knows the doctor well, the readings will differ from those secured at first.

Blood-pressure.—That there exists a hypotension of the pulse in pulmonary tuberculosis is generally recognized, but there is considerable difference of opinion as to the time of its first appearance. Certain authors, especially those of the French school, believe it is low in the earliest stages of the disease, often before any other change can be noted. This, however, is not the general view, and the writer has not found low pressures in his very early cases, but it has been in the moderately advanced cases that a low blood-pressure is common.

Burckhardt ('06) found hypotension in progressive cases, whether afebrile or not, but in nonprogressive or afebrile cases he got normal readings. A fair number of the writer's patients at this stage have shown a pressure of from 90 to 120 mm. of mercury, and Teissier ('05) considers 120 to 130 the usual figure in first- and second-stage cases, and 80 to 100 in third-stage cases. Cornet quotes Marfan as finding low pressure in 97 out of 100 cases. Different authors have different views as to what can be considered a low pressure; any pressure under 130 mm. is so regarded by West.

T. C. Janeway, in his recent work on blood-pressure, quotes the estimates of normal pressure made by various authors, using the Riva-Rocci apparatus, which is practically similar to Janeway's and Stanton's sphygmomanometer.

In adult males Gumprecht found an average of 140 mm.; Hayaski, 132 mm.; Heuser, 137 mm.; and Thayer, of Johns Hopkins, in his cases, between twenty and fifty years of age, found 139.9 mm. The whole series averaging 137 mm., with maxima and minima varying from 96 to 180. Janeway himself considers from 110 to 150 normal. In tuberculosis, Naumann, in 100 cases, found a pressure over 130 in 69 per cent, over 115 in 13 per cent, and under 115 in 18 per cent, and considers 115 low pressure. Stanton, in a personal communication, tells me he considers 115 low pressure in this disease, and after considerable use of his instrument, controlled at times by Janeway's, I am inclined to consider this a fair estimate; but when formerly I used Gaertner's instrument, which is applied to the finger tips and not to the arm, I found rather higher readings. However, in my early cases pressure has

not usually been low, and I have been surprised to find that pulses which by the finger estimation seemed to have poor tension, would show quite fair readings with the instrument.

In advanced cases low pressure is so common that high pressure should suggest renal changes, which should call for investigation of the urine, or a pulmonary congestion, or an impending hemorrhage.

Teissier notes that high tension is present in tuberculosis temporarily preceding hemorrhages or acute congestions, and permanently in fibroid phthisis with emphysema, in cirrhotic kidneys, or in diabetic tuberculosis, and a gradual rise exists when the process in the lungs is lessening in intensity and a cure is occurring; or in tuberculosis of arthritic subjects.

The low pressure in tuberculosis has been ascribed, like so many other symptoms, to the effect of the tubercle toxin, as also to a weak heart, or to anemia, Bouchard ('05) having extracted a vasodilator principle, ectasine, from tuberculin. Just as a lessening of tachycardia has a good prognostic meaning, so a rise of blood-pressure and a good tension of the pulse, if the kidneys are sound, is almost as favorable a sign as a slow pulse.

The *heart* presents few symptoms in tuberculosis. Since Laennec first pointed it out, a diminution in its size was, until recently, universally admitted, and Brehmer regarded the small heart as a causal factor and used it to fortify his views as to the etiology of the disease.

Louis long ago reported 112 autopsies in tuberculous cases, in which about fifty per cent showed unduly small hearts ('04), and Resch ('05), in 120 cases, found about the same percentage. Similar results have been gotten by other observers.

In recent years, as the result of autopsies, some have denied that the heart was small, Hirsch finding it enlarged in forty-four per cent and small in but five per cent; but, as he himself admits, in old cases there is a hypertrophy and later a dilatation of the right side, due to pulmonary obstruction. Bouchard and Baltazar ('05), by orthodiagraphy, measured the heart in 100 nontuberculous people, and in 100 with tuberculosis, and in the latter, in the first and second stages, found the heart smaller than normal.

That autopsies should differ from clinical findings can easily be understood when we recall that autopsies are, with few exceptions, made on advanced cases of tuberculosis and on hospital material. In the former, as is well known, diminution of lung area and fibrosis place a strain on the heart which results quite commonly in its hypertrophy and dilatation. In the latter, as a result of alcoholism, the kidneys are very often cirrhotic. Thus autopsies would be apt to show large hearts

where fluoroscopic and other examinations in earlier cases would show the reverse.

As a result of systematic percussion and mensuration of the heart, and of fluoroscopic examinations in all cases, it may be said that in a large number of cases such a small heart will be found, though whether it is congenital, and to be considered as a cause, or due to atrophy, and to be regarded as an effect, cannot be stated. Anyone who will use the X-ray carefully will agree with this view.

Hutchinson ('06) has lately made the interesting discovery that in the animals at the London Zoological Gardens, those most prone to tuberculosis had hearts whose weight was less than $\frac{1}{100}$ of their body weight, while those who were immune had hearts heavier than $\frac{1}{100}$. Thus the deer, with a heart $\frac{1}{90}$ its body weight, is almost insusceptible, while the antelope, with a heart $\frac{1}{200}$ its body weight, is very susceptible to tuberculosis. The sheep, with a heart $\frac{1}{100}$ its body weight, is relatively immune; the cow, whose great susceptibility is well known, has a heart only $\frac{1}{250}$ of its body weight. As a result of a few carefully made measurements on sanatorium cases, he thinks he has confirmed his views drawn from these animal measurements, finding the heart small in the majority of the cases, and he has come to consider a weak, undersized heart as "one of the most constant and significant conditions present in consumption."

Displacement of the heart in moderately or far-advanced cases is very common, and is due chiefly to fibrosis. It can come on relatively soon, develops slowly, and can reach a very pronounced degree, the heart often being dislocated completely into the right side or displaced far over to the left. Such displacement is presumptive evidence of fibrosis, and the location of the apex should, therefore, be determined carefully in every case.

In pleurisy with effusion, or more especially in pneumothorax, displacement occurs rapidly, can be very marked, and may be accompanied by circulatory disturbance from bending of the great vessels and traction on the vagus. In a rapidly collecting pleuritic effusion purposely left *in situ* for its pressure effects, the writer saw a severe and alarming syncopal attack from this cause demanding immediate relief. In left-sided pneumothorax the heart will show extreme degrees of dislocation, and the writer has several times seen it drawn entirely into the right thorax, though after a while, unlike in fibrosis, the heart in these cases partially returns to the left.

Aside from pulmonary stenosis, whose causal relation to the development of tuberculosis in the lungs cannot be doubted—Meisenburg ('02) found eighty per cent of all patients in the Leipzig clinic died of tuberculosis—valvular lesions have no relation to tuberculosis, though retrac-

tions can at times give rise to various indefinite murmurs. Mitral stenosis was at one time considered to antagonize tuberculosis, and D. Rothschild ('05) considers that it confers a marked immunity, and that if tuberculosis develops on a preëxisting heart lesion, it runs a mild course; but this is contrary to the writer's experience, and Norris ('04), in an excellent paper on the heart in tuberculosis, says: "In view of the frequency with which tuberculosis of the lung has been found associated with valvular heart disease, we are forced to conclude that the latter exerts, if any, but very slight influence on the former, either as an inhibitive or curative influence, even if satisfactory compensation is maintained."

Hypertrophy and dilatation of the right side of the heart, owing to resistance in the lesser circulation in the lung from obliteration of so many blood-vessels, is seen in some cases of extensive tuberculosis, being present in 46 out of 1,276 cases (Phipps Institute Histories). Such a condition may quite frequently be demonstrated by the fluoroscope when other methods fail to reveal it.

A subclavian murmur (see auscultation), due to kinking of the artery by apical contractions, is not uncommon, but has not the diagnostic value ascribed to it by Ruehle, as it has been shown that it can occur in other conditions.

Accentuation of the pulmonic second sound, with or without reduplication, is very commonly found, but is not of diagnostic value. The same may be said of a roughening of the tricuspid systolic sound, which the writer has noted in a large percentage of his cases.

Pericardial frictions are at times found, but tuberculous pericarditis is usually overlooked, and is found more commonly at the autopsy table than by the bedside. Systolic retraction of one or other of the left interspaces, commonly the second, near the sternum, is often seen in cases with emaciated chests, and, as Ruehle points out, is due simply to air pressure on the thin, wide interspaces, and should be distinguished from retractions occurring at the apex of the heart as the result of pericardial synechiæ.

Digestive System.—On the integrity of the digestive system in tuberculosis generally depends the result of the conflict, and he who treats tuberculosis very soon learns to study its symptoms with especial care. On it, more than on any other part of the body, depends the outlook of the patient for recovery, for unless a proper amount of nourishment, properly prepared by it, is given to the cells, they will surely fail in their battle with the disease. From the moment the food enters the mouth, until its useless residue is thrown off, each step of the digestive act is of the utmost importance, hence every part of the alimentary tract should be most carefully watched to see that it functionates properly.

The *mouth* in early cases presents no symptoms of value, unless we accept the views of Fredericq, Thompson, and others, to which G. Sticker, in 1888, drew attention. He described a sharply marked red line at the border of the gums, especially of the incisor teeth. While this line is present in some tuberculous cases, it is also found in other conditions, and in tuberculosis it is found chiefly in advanced cases and rarely in incipient ones. It is not a sign of value.

The *tongue* in early cases shows no alterations which can be connected with the disease, though where digestive disturbances are present it is apt to be slightly coated. The frequency of dyspepsia in moderately advanced cases accounts for the frequency of a coated tongue in such cases, while in advanced cases there is very frequently found the red, shiny tongue of all chronic cachexias.

The condition of the *teeth* in pulmonary tuberculosis should always be carefully looked into, as the bad effect of caries on digestion is well known, and in advanced cases such caries is unduly common and gives much trouble. In those in whom we find what has been called the tuberculous constitution the teeth are apt to be unduly transparent and delicate, probably from a deficiency of lime salts, and not infrequently transverse ridges are present, which, like the transverse white marks on the nails, probably correspond with periods of lowered vitality.

The *pharynx* shows chronic pharyngitis, with undue prevalence of adenoid tissue on the posterior and lateral pharyngeal walls, which often are studded all over with the small lymphoid masses of follicular pharyngitis. Extreme pallor of the hard and soft palate and posterior pharyngeal wall and epiglottis is common in old cases.

Follicular pharyngitis is very common and develops in old severe cases into pharyngitis sicca, which can cause considerable inconvenience, while thrush and aphthous stomatitis are at times troublesome in the last stage. Behr found twenty-five per cent of chronic granular, or dry cases of pharyngitis.

Tuberculous pharyngitis is fortunately very rare, for it is excessively painful and its course is uniformly fatal. It occurs, according to the classification of Barth ('80), who has written a very complete monograph on the subject, in three forms: (1) An acute tuberculous folliculitis, (2) a diffuse miliary tuberculosis, and (3) a chronic ulcerous tuberculosis. It begins with pain and the appearance of isolated or confluent whitish-yellow elevations, rapidly spreading and coalescing into platelike masses, hard to the touch and with little or no inflammatory areola. The pain in the throat becomes lancinating and burning, and does not remit. Dysphagia appears, and there is troublesome salivation and pain running into the ears. In a very marked case, in which death occurred before ulceration took place, the tubercles spread up the

posterior pharyngeal wall, and from the soft to the hard palate with surprising rapidity, each day showing a distinct advance, while the pain was excessive and scarcely affected by anodynes. If the patients live long enough, ulcers form and spread rapidly.

The *tonsils*, while frequently enlarged, Behr ('05) finding abnormal tonsils in sixteen per cent of cases, show no special ocular changes. Hypertrophy of the lingual tonsil, while not more common in tuberculosis than in other conditions, is more troublesome, as it often causes an obstinate hard cough by pressure on the epiglottis, disappearing on the removal of this pressure.

The *stomach* presents marked alterations from the normal. A large number of cases of pulmonary tuberculosis begin as a dyspepsia, and few fail sooner or later to show some evidence of gastric disorder. Janowski ('07) found gastric disturbance in fourteen per cent of 700 incipient cases, and eight per cent of gastric and intestinal disturbances.

Many patients report themselves as having always been poor or fickle eaters, and Behring ('04) regards this lack of good appetite as an early symptom of the presence of tuberculosis in the system. It could usually be considered rather as an excellent predisposing cause through its depressing effect on the general nutrition.

In incipient cases we find very commonly loss of appetite in a moderate, but not at this time in an extreme, degree, a sense of discomfort, fullness and weight after eating, belching, pain, signs of motor insufficiency and hyperacidity. Fox ('91) quotes Fenwick, who found hyperacidity in fifty-six per cent of 200 cases. Pasquier ('03) found hyperchlorhydria in sixty-nine per cent of his incipient cases and in fifty-seven per cent of his second-stage cases.

Vomiting after meals, which Grancher and Barbier ('97) and Fox ('91) regard as a very early symptom, was not found in the writer's early cases, which agrees with Janowski ('07), who found it rare, though it is quite common in somewhat more advanced cases, being usually excited by the cough which eating is so apt to produce, but at times by the effort to bring up very tenacious sputum. It can be very obstinate, and coming on after meals may at times seriously affect the nutrition. Tenderness in the pit of the stomach on pressure, or pain appearing after eating, those common accompaniments of hyperacidity are frequently seen.

Fermentative dyspepsia is a very common complaint with tuberculous patients, and is often seen very early. The taking of food is shortly followed by a sense of fullness and distention with belching, and few of the lesser symptoms are so hard to remove.

The frequency in tuberculosis of those sequelæ of motor insufficiency, dilatation, and dislocation, has not been sufficiently recognized. Marfan

alone laying stress on it. If the stomach is mapped out in all cases, dilatation will be found in a large percentage of the moderately advanced cases, and in some of the early cases dilatation, often of an extreme degree, at times accompanied by dislocation. In view of the importance of perfect digestion in tuberculosis, we should, therefore, never omit from our physical examination a mapping out of the stomach.

In advanced cases there are present the signs of chronic atrophic gastritis, a severe and often absolute anorexia, a disgust for food so great that the very sight of a meal induces vomiting, hyperacidity, and absence of heartburn. Pasquier ('03) found hypochlorhydria in seventy-six per cent of his advanced cases. Digestion is, moreover, further hindered by the effect of the high fever, and, as has been noted in discussing anorexia, the chief meals must, therefore, be taken at the periods of lowest temperature.

Since the progress of the case depends so largely on a proper functioning of the stomach, it is evident that in future more and more attention will be paid to analyses of gastric secretion in tuberculous patients, and their diet will be regulated accordingly. When this is done we shall get better results than ever before.

The Intestinal Canal.—In early or in moderately advanced cases constipation is surprisingly common, and cathartics are frequently needed. While this may in part be explained by the limitation of exercise in the beginning of a rest cure, this cannot explain the undue frequency of this trouble in the tuberculous, and it must have some connection with the presence of the germ in the body.

Autopsies demonstrate intestinal lesions in a large number of cases, Heinze, reported by Müller ('04), finding them in 630 out of 1,226 cases of pulmonary tuberculosis; Janowski ('07) found 13 per cent of intestinal symptoms in 700 incipient cases and 8 per cent combined gastric and intestinal; Fenwick and Dodwell, in 500 out of 883; Eisenhart in 556 out of 1,000. From these statistics it would be natural to suppose that diarrhea and intestinal pain would be prominent in the disease, but, strange to say, this is not the case, and even where after death extensive ulceration has been found, often there will not, during life, have been the least intestinal disturbance. Fox ('91) found diarrhea in 72 acute cases where ulceration was present, only 36 times, and in 36 chronic cases he found 66 per cent of ulcers and 41 per cent of diarrhea.

In the beginning there are no intestinal symptoms, unless we so consider the marked tendency to constipation already noted, the dyspepsia at this stage being chiefly gastric. The diarrhea which Fox considers at times an early symptom has not been present in the writer's early cases. Fox believes that there is an irritable condition of the lower

bowel and undue liability to diarrhea on slight provocation, such as slight dietary errors, chilling, or hot weather, and due to a catarrhal inflammation of the mucous membrane. Cornet also considers it an early symptom, and ascribes it to the swallowing of sputum, the mucous membrane being irritated by the proteins of the bacillus, or else to the effect of the absorption by the blood of large amounts of toxin, but early cases do not have large amounts of sputum, and undeniable as are the remote effects of the tubercle toxins on which Cornet so frequently insists, it would seem improbable that they are present in large amounts in incipient cases. In moderately advanced cases there is very frequently flatulence and intestinal indigestion, which can at times be very troublesome, and in this stage also we will find, though not often, an obstinate diarrhea due to catarrhal colitis, which may simulate a tuberculous diarrhea.

However, it is usually only in the third stage that the intestinal canal gives much trouble, and diarrhea is at this time much more common. Fox's statement that fifty per cent of old cases have diarrhea is correct, if dealing with patients of all social classes, but it must be remembered that this will vary according as the patients are hospital or private patients, the careless habits and poor hygiene of the former in their past life, and the generally unfavorable conditions under which they have lived, rendering them more liable to the severe manifestations of the disease than the more carefully nurtured patients one generally sees in private practice.

Tuberculous diarrhea is due either to ulceration of the bowels, or, less commonly, to amyloid change, but Fox, and more recently J. Walsh ('06), consider that the nephritis of late tuberculosis may account for some cases. It is wise to be guarded in a diagnosis of amyloid diarrhea, which cannot be made safely unless changes in the liver and spleen and albumin in the urine and polyuria are found. Williams ('87) would differentiate the amyloid from the ulcerous diarrhea by the fact that the former is not very profuse, is watery, and has some correspondence with the sweats, lessening when these are profuse. There is no tenderness of the bowels, the tongue is more furred than red and raw, as in the ulcerous form, and the liver and spleen are enlarged.

The majority of diarrheas in the third stage can safely be ascribed to tuberculous ulcers, but a positive diagnosis is almost impossible, the presence of bacilli in the stools being rendered valueless by the impossibility of excluding the swallowing of sputum. The stools of such a diarrhea are apt to be unusually fetid and slimy and contain pus, and at times are streaked with blood. Louis, quoted by Renzi ('94), considered a diagnosis of tuberculous ulceration justified when a tuberculous patient suffered more than six weeks with a continuous diarrhea,

and Traube thought such a diagnosis safe in the presence of persistent and active diarrhea if dietary errors and amyloid change could be excluded and the stools were colicky and bloody. The combination of colicky pains coming on shortly after taking food, pain on palpation, ravenous appetite, rapid emaciation, and pus in the stools, point with practical certainty to a tuberculous ulcerative enteritis, and the appearance in a tuberculous patient of obstinate colicky pains after meals should excite suspicion.

Intestinal hemorrhages are much less common than in typhoid, and intestinal perforation is still rarer, Eisenhardt giving the frequency of the latter as five per cent of all cases of intestinal tuberculosis; Fenwick and Dodwell, ten per cent. Unlike the perforations occurring in more acute diseases, they may produce few or no symptoms, and apparently not infrequently heal spontaneously.

Two rare forms of intestinal tuberculosis are the hypertrophic and the stenotic. The former is described by Mathieu ('04) as being characterized by hypertrophy of the cecum and ileocecal region of the bowel, coming on gradually in cases of very chronic course. There is dull pain in the right iliac fossa, with attacks of colic and diarrhea with vomiting. Slowly there develops a sausagelike mass in the cecal region with signs of chronic stenosis. The stenotic form is due to scar formation in the circular ulcers, and is confined to the lower third of the small intestines. It is commonest in fibroid cases, and often there are no pulmonary symptoms at all, so that these cases are apt to be mistaken for cases of syphilitic stenosis. They are, as a rule, very gradual in their development, and, as the constrictions are located in the small intestine, constipation is usually absent. The chief symptoms are periodic and increasingly severe colicky attacks, generally accompanied by vomiting, during which, in emaciated patients, the distended coils of the intestines can be seen to move under the thin abdominal wall, and the gurgling of gas can be heard.

Tuberculous peritonitis is, strictly speaking, a complication. Buschke found it in 16.5 per cent of 1,393 autopsies. While a peritonitis can occur acutely as the result of the perforation of an ulcer, or by extension of inflammation through the peritoneum covering the base of a deep ulcer, this, of course, is not a real tuberculous peritonitis.

Chronic tuberculous peritonitis generally comes on insidiously, with the collection of fluid in the abdomen and a gradual development of tympanitic distention. However, the fluid is often encapsulated, and thus may not be demonstrable, while at times there is no fluid at all. Pain is usually present, but is rarely severe, and generally there is only a sense of abdominal distress. The temperature is variable, often being absent for some part of the time. Palpation of the abdomen will

demonstrate tumorlike masses produced by the adhesion of the coils of intestine, but this may not be discoverable if there is much distention. In some cases if the peritoneum is richly studded with tubercles, palpation gives a crepitus.

The Liver.—The liver does not present any symptoms, but signs of imperfect liver function in patients who are practicing hyperalimentation are common, and while most of the so-called "bilious attacks" which are then so frequent are probably due to gastroduodenal catarrh, it is reasonable to suppose that the liver, as well as the stomach and bowels, are deranged. Ullom ('06), while finding liver tuberculosis in a large percentage of cases at autopsy, found its clinical recognition impossible. In nearly every case he also found passive congestion of the liver, but his material consisted of advanced cases in the very poor, and doubtless examinations in earlier cases, if possible, would show other results.

Urinary System.—While the *kidneys* are affected in a large number of cases, the symptoms are usually not marked and are more often overlooked. In incipient cases the *bladder* and kidneys are usually normal, although Papillon ('97) and Robin ('97) speak of frequent micturition and polyuria as early symptoms. The *urine* is usually negative in the beginning of the disease, but later on, if carefully studied quantitatively, can give valuable evidence of the tissue waste that is occurring, and French authors consider that a demineralization of the system is shown by the excess of earthy phosphate in the urine, although Ott ('03) does not corroborate this. Croftan ('03) found an excess of calcium excretion.

This phosphaturia is considered by Grancher ('97) an evidence of cell destruction, and what he says is so suggestive that it is well to quote from him at length:

> The peculiar demineralization of the tuberculous from this point of view is worthy of great attention by all observers. It shows that uncomplicated tuberculous consumption follows special laws, and that its mechanism does not resemble that, for example, of diabetic consumption. The low content of the urine in sulphur, the considerable increase of phosphates, combined with the nitrogenous derivatives of insufficiently hydrated albuminous substances, indicate a destruction bearing especially upon the phosphorized albuminoids, nucleo-albumins, and nucleins. These bodies exist only in the cells and especially in the white cells. . . . From the first the tuberculous utilize, as we have seen, against the bacillus, the polynuclear leucocytes, and then the mononuclear. The destruction (*consommation*) of these elements is in direct proportion to the production of toxins. The necessity for the tuberculous to meet this waste of leucocytes is shown by the special activity of the bone marrow which one sees in the tuberculous, or which one can produce experimentally by the

inoculation of tuberculin or the formation at a distance of a local tuberculous focus. To meet this excessive waste of phosphorus and of nitrogenized substances, the formative cells of the marrow borrow their phosphorus from the bones; as for the proteid substances, they can only get it from the food, and for lack of that from the fleshy reserves of the organism, especially the muscles. . . . The appearance in the urine of the tuberculous, along with an excess of phosphorus, of those products of disassimilation of nucleins, xanthin, hypoxanthin, and uric acid, is a proof of this especial disassimilation. The practical result of what precedes is that the tuberculous have need of great quantities of leucocytes, because around new lesions many are destroyed. . . . The loss of phosphates in the urine gives the measure of the destruction of leucocytes—that is to say, of the importance of the phenomena of the struggle which is occurring in the tuberculous foci, and at the same time it also gives the measure of the production of leucocytes—that is to say, of the resources of the body. The variations of demineralization can therefore, according to the circumstances, have a favorable or unfavorable meaning to the doctor. If the phosphates lessen while the general condition is improving, it would indicate that cellular destruction is less active, that the tuberculous process is dying out; if they diminish in the presence of emaciation and aggravation of the symptoms, it shows that the organism is becoming exhausted and that the means of defense—the formation of leucocytes—is weakening.

De Renzi also notes that one can often find a direct relation between excretion of earthy phosphates and the emaciation, and that the lime salts are increased in early cases and lessened in late ones.

Albuminuria, while at times present in incipient cases, is not more frequent than in the nontuberculous, but in advanced cases it is very common, J. Walsh finding it in 47 per cent of his old cases, Fox in 32 per cent of his chronic cases and 8 per cent of his acute cases. Montgomery ('06) was able usually to find it, though in very small amounts. Cornet considers it an evidence of tuberculosis of the urinary tract, but in view of the frequency of nontuberculous nephritis in this disease, it would not be safe to base a diagnosis of tuberculous kidney on it. Fox considers it due to amyloid kidney, but certainly amyloid kidney is far less common in this disease than is albuminuria. Senator (86) considers it often the result of a chronic parenchymatous nephritis, which he considers, in Berlin, to be most commonly due to tuberculosis, and J. Walsh considers this form of nephritis to be the typical nephritis of tuberculosis, having found it in 30 per cent of his cases. Müller, however, considers granular kidney the typical tuberculous kidney, quoting Landouzy and Bernard to the same effect. West ('02) considers granular kidney not connected in any way with tuberculosis.

The relative frequency of a chronic nephritis in old tuberculosis, and the fact that tuberculous nephritis often runs a symptomless course, should cause us to examine the urine of all second- and third-stage cases for albumin, for uremic coma is not an unknown ending to tuberculosis and may come as a disagreeable surprise.

Ehrlich's diazo-reaction, at one time hailed as a diagnostic measure of great value, has lost all claims to such a title since it has been found in typhoid, measles, and other diseases. Prognostically, Holmgren, of Stockholm ('06), considers it of the greatest value, but while if persistently and intensely present a bad prognosis is justified, its absence cannot be considered a good omen, for it can be absent in severe cases, and it is occasionally transiently present in early and favorable cases. A. Williams ('07) reports that in negroes, however severe the case, he never found the reaction, though it was present in the majority of his severe cases occurring in whites. It must be recalled, in a study of the diazo-reaction, that a most careful and accurate technic is necessary, and that great variations in results can be produced by the individual interpretation of border-line reactions by different observers. The presence of albumose in the urine, which has been dwelt upon especially by Krehl, Matthes, and Schultess, has been suggested by Ott as a means for deciding whether temperature following on exercise is harmful, and such exercise, therefore, contraindicated or not. If albumose appears in the urine he considers rest necessary, but in its absence does not consider temperature an absolute contraindication to exercise. Webb, of Colorado Springs, has reported success in using this method of control.

Renal tuberculosis can advance to a considerable extent before it manifests itself by symptoms. These symptoms are discomfort, weight, and pain in the lumbar region, pain on palpation, and frequent and painful micturition. Blood appears early in the urine, generally in small amounts, but at times in larger quantities, but does not recur frequently, a point which Fox uses in distinguishing it from the hematuria of renal cancer. The urine, which is always acid and contains albumin, shows bacilli, chiefly found in bundles and sheaves. Ninety per cent of Walsh's cases, which were advanced ones, showed bacilli.

When scanty and isolated they must be differentiated from smegma bacilli, first by great care in collecting the specimen by catheter, and second by differential decolorization. Smegma bacilli, like tubercle bacilli, are not decolorized by five per cent watery sulphuric acid, but unlike these yield up their stain in three per cent hydrochloric acid alcohol. Along with these symptoms there are often symptoms of tuberculosis of the bladder, testicle, epididymis, vas, or seminal vesicles, and any suspicious urinary symptoms should cause us to examine these

organs. The rise of temperature is slight and apt to be intermittent, the general condition very good for long periods.

The Generative System.—The old question as to whether the sexual desire is increased or diminished in the tuberculous is one which, by its very nature, and by the unwillingness of female patients, at least, to give information, cannot be settled by clinical observation. Various men will form various opinions, largely according to the class of patients they observe and their own mental attitude. The general impression of clinicians has been that the tuberculous patient shows an excessive sexual passion, and various examples of sexual life carried on actively until very shortly before death have been reported, but in so far as observation in practice has been able to inform him in this matter, the writer has not noted any increase that was not natural to people who are being highly fed, who exercise but moderately, and are thrown into intimate intercourse day after day, and under such conditions many a male patient is apt to become unduly alive to the charms of his female copatients and to allow his idle imagination too much scope. Cassaet thinks tuberculous women more excitable than men, but such a statement would be very hard to substantiate. Louis, with a very large experience among Frenchmen, thought that in advanced cases the sexual passion was impaired. That intercourse has a harmful effect on most patients is frequently noted, the visits of husbands to wives, or vice versa, too often being followed by rise of temperature and aggravation of symptoms. Moreover, intercourse shows its harmful effects directly at times by causing pain in the diseased lung and increase of cough, indicating that it probably has some local congestive effect.

Menstrual irregularities in women are common and are of two sorts, a missing of the menstrual period in the incipiency of the trouble, chiefly in young girls, and which passes off as they improve, and in old cases an absolute cessation of the menses. In the former its reëstablishment shows increasing vitality, and of course is a good sign, but in late cases it is rarely reëstablished, and as a drain on the system is thus saved it is not desirable that it should be. At the time of the menses hemorrhages are unduly common, and attacks of pulmonary congestion are much more apt to occur at such times in women than at any other, so that the doctor learns to dread them. The effect of the menses on the temperature has already been noted under Fever. The rise generally begins the day before the flow sets in and lasts until it is well established.

The Bones and Muscles.—The osseous system gives rise to no symptoms in pulmonary tuberculosis. The muscles show wasting, both generally and, before general wasting appears, locally over the

site of the pulmonary trouble, this latter being in part responsible for the flattening of the upper thorax seen on inspection in the earlier cases.

The local contraction of the muscles on percussion, called myoidema, and described first by Stokes ('82), has been raised to the dignity of a symptom by some authors, but, as Stokes said, there is nothing in this muscular irritability peculiar to phthisis. It will be found in many wasting diseases, and it would be rash to try to strengthen a doubtful diagnosis by it.

The Skin.—A considerable number of patients have, and have had for years previous to their sickness, a delicate, transparent skin, through which the blue veins show, and which flushes easily and quickly, as well as fine, silky hair. While this speaks for a poor resisting power, it occurs in many who do not develop tuberculosis, and is only useful as an index to the constitution. The majority of patients in the beginning show no unusual texture or quality of their skin, but as the disease advances, and wasting occurs, trophic changes in the skin very commonly appear, and in advanced cases are very pronounced, the skin being thin, relaxed, and pale. In such cases the skin is practically never normal, being either unduly dry or moist and clammy.

This dryness, with a fine, branny desquamation, is the *pityriasis tabescentium* so often noted, and by some has been classed as a diagnostic sign, but it is not in any way confined to this disease. *Pityriasis versicolor*, sharply marked, yellowish or even orange-colored patches, slightly elevated and tending to gradually coalesce into larger and larger masses with rounded borders, is due to the *microsporon furfur*, and is fairly common, especially in the lower classes, with whom water and soap are not popular, but is not often seen in patients of the better classes. It is chiefly found on the lower thorax and upper abdomen, and on the back about the scapulæ, and usually yields to ablutions and antiseptics.

Shively ('00) reports in his dispensary cases a waxy pallor of the end of the nose, spotted over with distinctly prominent brownish-yellow openings of the sebaceous glands. The same is also seen on the chin. He considers it common enough to have diagnostic value. The writer has not been able to find it, however, in his cases. The skin of advanced cases will at times show purpuric spots shortly before the end.

The *hectic flush* of tuberculosis varies from a scarcely perceptible pink spot, sometimes seen quite early in the disease, to a blotch of brilliant red in the midst of the deadly pale skin of an advanced consumptive. By it one can roughly guess the chief seat of the trouble, as it is very generally confined to the cheek of the involved side, or if bilateral is much more marked on the worse side. Owing probably to

nervousness, many patients during an examination sweat very freely from the axillæ, the perspiration running from them in rapidly following drops, but this is not confined to tuberculosis, being also seen in very nervous people.

As in all other exhausting diseases, *œdema* appears near the end, and indicates a failing heart. The Hippocratic *clubbed fingers*, a bulbous enlargement of the ends of the fingers, and at times of the toes, is due not to any change of the bones, as was once supposed, but to an increase in the fibrous tissue of the part. It generally develops slowly in chronic cases, especially if much suppuration is present, but at times comes on rapidly, as in a case reported by West, which developed in less than two weeks. Pollock found it in twenty-nine per cent of all his cases. Ruehle and Cornet ascribe it to interference with the return circulation, and Sokolowski ('06) to the wasting. Since it occurs in congenital, right-sided heart lesions, the former explanation seems the more reasonable. It is not confined to tuberculosis, being even more marked in simple bronchiectasis, and especially, as noted, in right-sided heart trouble. Even when clubbing is not present, the finger nails tend to become unduly arched, and, like the teeth, are likely to show transverse and longitudinal ridging, the former marking periods of lowered vitality. The cyanosis of the skin has already been referred to. (See Cyanosis.)

The Hair.—The hair in early cases is just as apt to be strong and coarse as silky, fine, and red or golden, though for centuries such hair has been supposed to be typical and to be associated with a lessened resistance to this disease. In the later stages the hair shares in the general denutrition, and is dry, lusterless, and lifeless.

The Psychical Condition.—In tuberculosis the psychical condition varies between wide limits, and since there has been an undue tendency to accentuate the psychical abnormalities of these patients, it is well in the beginning to note that a large number of patients are absolutely normal people—people who can and do face with courage and indomitable determination the sad changes in their lives brought about by the disease; who choke back the tears and groans that would seem almost excusable, and put on a brave face to meet misfortune. Every physician can recall many such whose courage and cheerfulness compelled his admiration, and in whom there was no trace of those mental changes dwelt on by Heinzelmann ('94). F. Wolff ('94), referring to this author's views, wisely says that the various morbid mental states which he considers the results of tuberculosis are much more likely its precursors, and that in these peculiarities of character we can often find the cause of the disease. Fox ('91) also says: "While phthisis may occur in persons of any mental constitution, it does not appear sensibly to modify

that peculiar to the individual, and in consequence at times all variations may be observed."

Wolff divides people into those of sanguine and those of phlegmatic temperament, and notes that the former were far more numerous among his tuberculous patients, a fact which every man who handles this trouble will have recognized. The disease is apt to pick for its own an undue number of the high-strung, the unduly sensitive, the talented, often the intellectually brilliant, as the history of literature shows, a point which has been dwelt on by Osler and by Wolff. The temperament of such people tends also to make them poor patients, while those of less emotional and calmer dispositions tend to do very well.

In its incipiency, an excessive and undue irritability and excitability are almost the rule. A man formerly good-tempered and easy to live with, will become captious and cross, and will be a sore trial even to those who love him most. It may be that the products of the germ may at this stage produce an irritation of the cortex, but anyone who has personally realized what it is to learn that so dread a disease has picked him for a victim, who knows what it means to have to change cherished plans and ambitions and dreams; what it brings of anxieties for the future for himself and for dear ones, will be apt to consider that such a condition is very natural, and not necessarily a part of the disease; which seems the more probable as this irritability is not so commonly found in women, and not at all in children, and as, after the first few months, when the patient has adapted himself to the inevitable and understands better the nature of the trouble, it generally passes off.

As the patient recovers from the shock caused him by realization of his condition he usually regains his equipoise, and is reasonably cheerful and hopeful; those who are permanently cast down being those more naturally pessimistic by temperament or unduly excitable and nervous. In every sanatorium will be found many who, to the doctor, knowing well their physical and financial condition, are a source of surprise and admiration. Such patients often serve as centers of brightness and hope to a whole household, and change what might easily be a sad, depressed collection of invalids into a jolly, bright, laughing crowd of "good fellows." In a large number of cases, however, depression is severe and difficult to overcome. This occurs generally in people of a naturally morbid or pessimistic frame of mind, and it is worth noting that this depression is more apt to trouble patients living in their own houses, often with affectionate relatives, than those living with other patients in special houses, where there is some demand made upon them to go outside of themselves and enter into the interests of other people. It is hardly necessary to dwell on the bad effects of such tendencies to

depression, and it will tax all the physician's magnetism and force to lift these people out of the "slough of despond" and give them a more normal mental attitude.

Neurasthenic symptoms are prominent in a large number of cases of pulmonary tuberculosis, and, as would be supposed, are unusually common among Jewish patients, who rarely have a normal nervous system, and who, when their active minds are taken off outside affairs, concentrate them on their physical condition, with bad effect. Fleeting thoracic pains, never staying long at one spot, and which give the patient a good deal of needless anxiety, are amazingly common among Hebrews, so that I have come almost to expect them with these patients. Irritative useless cough, hot flushes, which are taken for fever, sleeplessness, needless worry over trifles, are annoying and common in the hypernervous and neurasthenic. Such patients are apt also to be variable and excitable and to lack will power, and since persistence and will are almost essential to our patients if a permanent cure is to be accomplished, the whole temperament of these patients will have to be reformed, and the doctor will have to strive to awake and cultivate in them energy, hopefulness, and will.

Sleeplessness is very common in moderate degrees, but the writer has not met with it very often in severe forms. It may be an evidence of an empty stomach, yielding to food, or of unsuspected night fever, but it may also be of nervous origin.

The *intellect* is unchanged, and, indeed, is very often remarkably clear, though it is more quickly exhausted, like the rest of the body; but the world would be distinctly poorer if all the productions in literature and art of consumptives were wiped out, and one need only recall Robert Louis Stevenson, Chopin, Rachel, and Heine as a few among many whose work is part of the prized literary and artistic heritage of mankind.

It is in the last stages chiefly that we usually find the *spes phthisicorum*, the groundless hopefulness of the consumptive, which has been so often noted by writers on this disease, and which leads almost moribund patients to look with certainty to approaching cures on every slight diminution of temperature or symptoms, and to make plans for their future on their very deathbeds. However, this is not by any means as common as it is generally held to be, though at times it does unquestionably do much to lighten the gloom of a patient's last days. The profession has often been blamed for sending hopeless consumptives away to resorts, but in their justification it should be remembered that these sad and useless journeys are very often due to the patient and not to the physician, the former being convinced that all he needs to put him on his feet is such a change.

The *insanity* of tuberculosis, while dwelt on in text-books of psychiatry, will be rarely seen outside of asylums, where at times as a precursor, much more frequently as a sequel, of insanity, tuberculosis is frequent, accounting for a large number of the deaths in these institutions. The writer has had experience with but a few cases of the suspicious and melancholic forms. It can be of various varieties, but Régis ('95) quotes Clouston as considering mania of suspicion the most common form. Next to these is acute melancholia, with suicidal tendencies, while mania, dementia, and general paralysis are much less common. Chartier ('99) says: "It begins by alteration of the temperament and character, and continues with occasional acute delirious attacks, and ends in a melancholic depression, with ideas of persecution (mania of suspicion)." (In this state the writer has known patients to shut themselves up in their houses and refuse to see anyone at all and to reject assistance of any sort.) "In the last phase the patient falls into a sort of half stupor, or has a terminal attack of acute mania. This type exists, but it is nevertheless not general."

The peripheral nerves in tuberculosis are at times a source of symptoms. As in all depleting diseases, *neuralgia* is common, both in the extremities and more especially in the thorax, where it may be mistaken for pleurisy, though, unlike the latter, it is not increased by deep breathing or pressure.

Hyperalgesia of the skin of the chest is quite common, and is discovered frequently during percussion. It is commonest over the seat of active pulmonary lesions and during acute congestions.

Neuritis has been reported in the late stages, especially in the oft-quoted article of Pitres and Vaillard ('86). They divide it into (1) a latent form, (2) an amyotrophic form, and (3) a sensory form. The former gives no signs in life and is only found at autopsies; in the amyotrophic form there is generally degenerative motor trouble, and in the sensory form there are pains, paresthesiæ, hyperesthesiæ, and anesthesiæ. In a few cases the writer has met with obstinate sciatica, not due to Pott's disease.

The Special Senses.—No symptoms are presented by the special senses, unless we so consider the unilateral pupillary dilatations which are found not infrequently (6.8 per cent in Schaumann's cases, quoted by Cornet). Gröber ('05) claims that widening of the pupil on the affected side is of value, and can be brought out, when not present, by forced breathing, which dilates the apex and thus causes pressure on the sympathetic. According to Turban ('99), Rogne, in 1869, first noted this dilatation. The writer has found it as often on the good side as on the bad, so that it cannot be relied on in diagnosis. In severe cases, especially in the young, he has noted large dilated pupils quite

commonly, and has come to attach a bad prognostic significance to them, as showing a severe degree of toxemia.

The Larynx.—It is unfortunate that an examination of the larynx is so generally omitted from a physical examination of the lungs. It is a most important part of the respiratory tract, and shows involvement in a large number of cases, Schech ('98) reporting trouble present in 30 per cent of all cases of pulmonary tuberculosis, Turban in 18.2 per cent, and it often gives very early symptoms, so that we cannot afford to overlook it. The use of the laryngoscope is not difficult to acquire, and every physician can learn to recognize not only those advanced changes, such as pear-shaped arytenoids, turbaned epiglottides, perichondritis, or extensive ulcerations of the cords, which generally imply a fatal outcome of the case, but also the much more important slight early changes which are still curable, and which can be of assistance in early diagnosis (see Plate I).

In incipient cases of tuberculosis a weak voice has long been recognized, even by the lay public, as suspicious and suggesting a weak chest. While this is frequently the result of a slight laryngeal catarrh, it can also at times, as Fraenkel ('04) notes, arise from an improper innervation, and when due to unilateral cord paralysis is due to pressure on the nerves by tuberculous glands, and not to any tuberculous deposit in the larynx. A slight laryngeal catarrh is present in a large number of cases—16 per cent of 300 cases reported by Behr. In these cases the cords and arytenoids, instead of being congested in a mottled way, as is the case in tuberculous trouble, are evenly congested, and this, while possibly favoring a later development of tuberculosis, is not itself of a tuberculous nature and will often yield to proper treatment.

As Chiari ('05) well says: "All tuberculous people have a pallor and poor resisting power of the upper respiratory tract, and especially of the larynx, therefore they have a tendency to chronic, and also acute, recurring catarrhs. Especially are such cases suspicious in which one side of the larynx, a cord or arytenoid cartilage, is persistently red and thickened. Such patients are often hoarse. They are very sensitive to impure air, especially tobacco smoke. Their voices tend to get hoarse and tire quickly on speaking. Many tuberculous people never have any other laryngeal symptoms than these."

The first symptoms of a tuberculous laryngitis are a tickling or pricking sensation in the throat, as if one had swallowed a bristle, with some dryness and cough. Hoarseness, except as an impurity of the voice, is not at first present, and is, indeed, often absent, even when extensive lesions are found in the larynx.

Dysphagia is practically never present in early cases, although the patient often complains of "feeling his larynx" on swallowing, and

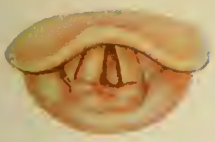
most patients complain of some discomfort or uneasiness in their throats, which they can generally localize correctly to the affected side, if the process is unilateral.

The earliest general change is either an anemia or a hyperemia of the larynx. Formerly anemia of the larynx was considered a very typical early sign, but it is not found as frequently as hyperemia, and Lennox-Brown ('99) quotes Cohen, who says that "hyperemia is the earliest sign in the acute, and anemia in the chronic form." The writer's experience is that anemia is common if the patient chances to be otherwise anemic or run down when the process develops, but unless other changes in the mucous membrane are present it is not a sign to be relied on.

The really valuable changes in this stage in the laryngoscopic picture are changes in the posterior commissure, the *processus vocalis* or body of the true cord, or in the false cords or arytenoids, the epiglottis and anterior commissure at this time not usually being affected. Of all these locations, the posterior commissure is very much the most common, Jurasz ('04) finding it the primary seat in 195 of 378 cases. The mucous membrane of the posterior commissure is either wrinkled and elevated into numerous grayish folds, which seen from above look like fine scallops running from side to side, or showing a general or more usually localized thickening, or tablelike elevation (see Plate I, Fig. 1).

Of the changes above noted the writer has found the grayish wrinkling (Fig. 6) to be the commonest early finding, but since it can be simulated by a chronic catarrh, it has not the diagnostic value of the tablelike elevation. This elevation generally occupies the center of the commissure, and usually has a vertical furrow or depression down its center, dividing it into two ordinarily symmetrical halves. At first it is but slightly elevated above the surface, but tends to get larger and larger, until it can stand out in a tumorlike mass. Schnitzler ('95) considers it "one of the sure signs of the beginning of tuberculosis, and when it has reached a certain degree, an almost certain sign of the beginning of phthisis, even without other appearances, and even while the patient is in the best of health."

The color is generally grayish-pink, but Schnitzler insists that this grayish color is not in itself, and aside from the elevation, of any significance, and that it can occur in chronic laryngitis. Keller, quoted by Scheeh ('98), found such tablelike elevations in thirty-six out of forty-eight cases. They can at times exist for years before the development of active pulmonary trouble. While the thickening is usually localized to the surface of the posterior commissure, at times infiltration will include the whole breadth of the arytenoids, thickening them greatly from before backward.



1

.—Tablelike Thickening and
vation of the Mucous Mem-
ne of the Posterior Commis-
e. The Mucous Membrane is
ally Rather Reddened, but
be Edematous and Hence Yel-
ish. (After Türck.)
2.—Small Erosions or Ulcers
FreeBorder of the Cords Giving
Characteristic "Nibbled-out"
earance. (After Schnitzler.)

2

3

3.—Thickening of the Righ
False Cord which Overlaps an
Hides Most of the True Cor
There is also Moderate Thicke
ing of the Center of the Aryt
noid Region. (After Türck.)
4.—Thickening and Injecti
of Insertion of Cords and Sma
Ulcer at the Base. (After Schnit
ler.)

4

6

5.—Superficial Erosion of the
per Surface of the Vocal Cords,
ry Typical of Tuberculosis. In-
tion of Cords. (After Krieg.)
6.—Grayish Wrinkling of the
sterior Commissure, not Diag-
tic, but very Suspicious if Com-
ed with Other Symptoms. Of
ss Value in those who Use the
ce in Public Speaking. (After
nitzler.)

5

7.—Ulceration of the Fi
Border of the Right Cord, P
ducing the Appearance of a Re
plication of the Cord. (A
Krieg.)
8.—Wartlike Growth, Ris
from the Posterior Commissu
Near the Insertion of the C
(a Favorite Location). (A
Krieg.)

7

8

These tablelike elevations tend to break down into ulcers, but as such ulcers are seen in profile from above, and as their bases tend to fill with exuberant pointed granulations, which hide the ulcer itself entirely, their nature may be mistaken. Later on these granulations may, and often do, enlarge to such an extent as to greatly affect the voice and embarrass respiration. In the place of such infiltrations we have at times tumorlike masses, although these are hardly an early occurrence. These solid excrescences or granulomata (Fig. 8) do not break down as do the infiltrations, but can persist for a long time unchanged, and are usually associated with a benign course, and are so firm and fibrous in texture as to render their removal difficult. At times we find, instead, pointed or even forked papillomata.

Next to the posterior commissure as the site of early changes is one cord, and more especially the posterior insertion of a single cord and its *processus vocalis* (Fig. 4). At this latter point we will often find very early some thickening and reddening, which soon develops into a small ulcer with a white slough, but its tuberculous nature is not as easily determinable as are the changes in the commissure.

Lake ('01) considers paralysis of the cord an early sign and due to a tuberculous myositis or to a toxic effect. The writer has found paralysis of the arytenoideus, but not in incipient cases. The cord itself shows either patches of congestion, going on to ulcer formation, or a solid, red, brawny infiltration of its whole length, by which it loses its luster and becomes spindle-shaped.

This is followed by erosions of the free edge or upper surface and the formation of ulcers. The ulceration of the edge is frequently in spots, so that the cord looks as if small pieces had been nibbled out of its edge (Fig. 2), or it may extend the whole length, in which case the parallel edges of the ulcer give the cord the appearance of being reduplicated (Fig. 7). The characteristic feature of tuberculous ulcers is their multiple character and their tendency to coalesce and extend laterally, rather than deeply (Fig. 5). Such ulcers on the cord are much commoner in the posterior third or one half, and frequently this portion is entirely eaten away while the anterior portion is well preserved.

In the false cords there is most often a very marked thickening and infiltration which broadens the cord considerably so that it overlaps, and often entirely hides, the true cord below (Fig. 3), like a folded blanket. The congestion is apt to be patchy, with areas of yellowish pallor between, and the surface of the cord granular, and in early cases ulcers are not common. The arytenoids often show for a long time, before definite lesions are found, localized patches of redness, so that they look mottled and angry (Fig. 4), with sometimes a white spot of anemia where the cartilage of Santorini projects.

In early cases they are not usually much enlarged, but at times will be found considerably swollen. The pear-shaped swelling running into the aryepiglottidean folds is of later appearance. The anterior commissure, as noted, is usually free at this time, but now and again there is seen protruding through the anterior ends of the cords a small polypoid mass of red granulation. The epiglottis at most shows small localized areas of thickening of its sharp upper edge, ulcers of its edge, the turban-shaped swelling and the edema of the epiglottis and aryepiglottidean folds not being early changes. In the same way, the ring-like ulceration involving the posterior commissure and both cords is also a much later condition and usually implies severe and hopeless trouble.

Severe *dysphagia* and *aphonia* are also late symptoms, but if the arytenoids ulcerate early the former may be present. Aphonia usually accompanies ulceration of the cords, and is not associated with dysphagia, while the dysphagia, which is often extreme and harassing, and yields to no anodynes, is commonest when there is epiglottic ulceration or, to a less degree, trouble with the arytenoids.

Perichondritis of the larynx is never seen in early cases, but generally results from infection of the cartilage from deep ulcers, the infection finally dissecting out the cartilage, which is thrown off as a sequestrum. It is accompanied by agonizing, throbbing pain.

In conclusion, it must be noted that usually the earliest tuberculous laryngeal manifestations are coincident, not with very incipient pulmonary lesions, but with moderately advanced ones, and that while primary laryngeal tuberculosis can exist, laryngeal involvement is not usually determinable in pulmonary tuberculosis until a considerable time after that in the lung.

Cough is one of the earliest and most constant symptoms of pulmonary tuberculosis (Roepke reported it in 93.8 per cent of 144 first-stage cases), and is so rarely absent that Ruehle ('87) says: "There is no consumption without cough," and while this is subject to certain exceptions, it is, on the whole, a fair statement. A large percentage of early cases give a history of cough, or at times of clearing of the throat, as the first change noted; no other symptom is so often the first to appear. Aufrecht ('05), it is true, denies this, saying that the cough of consumption is only a sequel of the laryngeal catarrh, and that such consumptives as have no laryngeal catarrh have no cough, but while patients in the incipient stage often have a cough of laryngeal origin (see Larynx), Aufrecht is alone in regarding it as the only cause of the early cough. He seems to be contradicted by the fact experimentally determined by Nothnagel and others ('94) that irritation of the diseased pleura produces cough in the absence of any laryngeal catarrh. Moreover, knowledge of the cough-producing effects of pleu-

ritic trouble would lead one to anticipate a pleurogenic cough in a disease in which an apical pleurisy is such an early occurrence. Certainly some cough is present in a large majority of all cases, and persistent absence of cough, as Lindsay ('04) says, points to the absence of tuberculosis.

The incipient cough is often preceded for some time by a weak voice which loses its timbre, or by a so-called nervous clearing of the throat, which occurs especially with every change of the weather. In such cases there is at first only a slight "ahem," which is not very noticeable and which is often completely overlooked by the patient, though noticed by his family. This occurs chiefly in the morning, and while a morning cough or clearing of the throat cannot be regarded as pathognomonic, it is always a very suspicious symptom. Such a cough is due either to a slight laryngeal catarrh or, as Grancher ('97) notes, to an irritation of the terminal filaments of the pneumogastric nerve in the lung, pleura, or bronchial glands. It should be distinguished from the hysterical cough, which never occurs in sleep and remains the same indefinitely. At first it is not productive of any sputum, but this is seldom long absent if carefully looked for. It is almost always a morning cough at first, Grancher being alone in considering it an evening one.

Instead of developing insidiously, it often begins suddenly, in the form of a bronchitis, the patient reporting that he "caught cold," and so many patients are treated for a long time for bronchitis, that it would be wise if every cough lasting more than a month were considered strongly suspicious of tuberculosis. The tuberculous cough at first disappears with warm weather, to reappear in the fall, the patient being thus led to harbor a false sense of security. However, when once well established, it does not stop in summer, though it is generally less in warm, dry weather.

Nothnagel's researches have shown that the respiratory mucous membrane is more sensitive, and that its irritation more quickly produces a cough in the area of supply of the superior laryngeal nerve, especially the interarytenoid space, rima glottidis, and epiglottis, and that this sensitiveness lessens lower down, temporarily increasing again at the bifurcation. In the bronchi it is slight, and the parenchyma is insensitive, while the pleura is only sensitive when inflamed. Krishaber found that superficial lesions cause more cough than deep ones, which corresponds with clinical experience, pleural lesions causing more cough than any others except the laryngeal.

At the same time it must be remembered that there are few more obstinate or more painful coughs than those of abscess of the lung, or those caused by a focus of acute softening, and unless such a cough is due to a neighboring pleurisy or to irritation of the bronchi, it would

seem to speak for an irritability of the parenchyma when inflamed. The early cough is rarely violent, unless laryngeal or due to enlarged bronchial glands.

Laryngeal cough is easily recognized by its paroxysmal nature, dryness, great intensity, and peculiar timbre. The cough due to enlarged bronchial glands is croupy and violently paroxysmal, and such a cough in a patient should suggest tracheo-bronchial adenopathy. The early cough does not cause pain in the chest, as the late cough often does, but the writer has noted that it can give rise to quite a severe neuralgic pain in the point of the shoulder on the affected side, a fact not noted anywhere except by Ruehle.

While cough, as is now so generally taught, can in most cases be suppressed by will power, there is sometimes in early tuberculosis such an intolerable itching, tickling sensation in the larynx that even those of strong will find the suppression of a cough impossible. This tickling is not always in the larynx, but at times somewhere along the course of the bronchial tree, and is very commonly felt under the lower part of the sternum, so that the patient supposes this to be the seat of the trouble, but the tickling bears no relation to the site of the pulmonary lesion. Morton, quoted by Osler, long ago noted that the cough could produce vomiting, but the conception of an early case in his day was what to-day would be considered an advanced one, and although so good an authority as Grancher ('97) considers that the early cough of phthisis, while not producing expectoration, produces vomiting, the writer has not, in his early cases, found this to be the case.

The effect on the cough of the personality of the patient is very marked. Neurotic, excitable patients, especially Hebrews, react most violently to cough stimuli, as they do to all other stimuli, and unless carefully trained will do a great deal of harmful and needless coughing, whereas the quieter and more phlegmatic person will, with the same degree of trouble, do much less coughing.

As already noted, when the cough has once begun it practically never ceases, except for short summer remissions or intermissions, until the end or until arrest of the trouble, and in the writer's experience this has generally been the last symptom to disappear. This obstinacy and persistence is one of the most typical features and every layman knows the evil omen of a persistent cough.

There is no typical cough in tuberculosis, and in all stages there may be a loose or dry, a hard or an easy, a high-pitched or a deep cough, though in general it is fair to say that in the beginning it is slight and dry, that it gradually loosens and becomes more pronounced, and is exaggerated by each exacerbation or extension of trouble, and toward

the end is usually loose, deep, and hollow. On the other hand it usually lessens as the process improves, and though Cornet ('07) denies that cough bears any relation to the disease, the writer believes he is justified in saying that steadily lessening cough almost always means improvement, and persistently increasing cough generally means the reverse. As the process advances it shows distinct morning and evening exacerbations. The patient at this time is not much disturbed by the cough at night, though he may waken once or twice to expectorate, but on awakening, or after rising, and sometimes not until after eating, he coughs a number of times, generally easily unless the sputum is very tenacious, and after having spat a few times and "cleared out his chest," he does not at first have much more cough during the day, except after eating or laughing (a prolific cause of cough) or after much talking, exertion, or excitement. At bedtime, or as soon as he lies down again, he has another attack of coughing, though at this time the expectoration is much less than in the morning, and consequently the cough is much more violent.

The cough at bedtime has been explained variously. De Renzi ('94) ascribes it to hyperemia of the apex, and thus explains the patient's tendency to lie on his sound side to prevent cough, also noting that lying down increases dyspnea, and that the respiratory center is always more irritable in dyspnea. Nagelsbuch ('04) believes it is caused by hyperemia of the larynx, and by the fact that in the recumbent position air strikes different portions of the laryngeal mucous membrane. As, however, cough on lying down is not noted in incipient cases, but only when sputum is present, it seems to be sufficiently explained by the movement of sputum to new areas or by change of position, as is also the morning cough, which is also encouraged by the returning sensibility of the mucous membrane which is lowered during sleep.

As the disease progresses and cavities form, the cough becomes more or less constant, the patient coughing at more or less frequent intervals during the day and expectorating at the same time. If large cavities are present, they impart to the cough the characteristic "hollow" quality supposed to be characteristic of consumption. The constant cough of the later stages can severely affect the health by disturbing sleep, using up strength, and by affecting the nutrition by causing vomiting after meals, while it also increases the danger of hemorrhage and hastens the end through exhaustion.

In this stage, and even earlier, the chief site of the trouble is severely racked by cough, which may make the lung ache and cause at times sharp pain, especially if there are pleural adhesions, and when, as is so commonly the case, such adhesions exist also at the base of the other side, the patient will feel them with every cough. The abdominal

muscles at times become sore from the excessive work put on them by the cough, and advanced cases suffer considerably from this.

A very severe, hard, dry cough comes with beginning softening, or during abscess formation in the lungs, and persists until softening is completed and the detritus or pus has been evacuated by expectoration. When large cavities exist the cough is usually very loose and free and may be intermittent, coming on in paroxysms until the cavity is emptied, the sputum coming up in large amounts and then ceasing until the cavity is full again. Patients with cavities are usually unable to sleep comfortably on the sound side, owing to the severe cough produced by the contents of the cavity emptying toward the dependent side, but this is not the universal rule; the reverse sometimes is the case.

In very sensitive people or in the old, or in those who have never been accustomed to proper ventilation in their bedrooms, cold air produces considerable cough, especially if it is damp. In the young or middle-aged hygienic education and outdoor life will overcome this quite promptly, though at first every breath of good fresh air will produce a cough, largely by autosuggestion, but in the old it is often unconquerable, and one cannot expect them to carry out an outdoor cure consistently.

An annoying and often obstinate symptom is a crackling and rattling in the chest, heard with every breath, caused by tenacious mucous in the air-tubes, and which can be heard at some distance from the patient. It often is very worrying and may be the cause of bitter complaint, and while often yielding to the use of alkalin waters, ipecac, or ammonium chlorid, it at times resists every effort.

Expectoration is present in almost all cases of pulmonary tuberculosis at some time in their course, and when reported absent one can by no means be sure that it is really so, many patients unconsciously swallowing all they raise. In 4,739 cases collected from statistics of German sanatoria by Montgomery ('06), 83.1 per cent had expectoration, and Roupke, quoted by the same author, found it present in 77.8 per cent of 144 first-stage cases. The swallowing of sputum is universal in childhood, up to at least the fifth year, and some adults, more especially women, never get over the habit, or else persist in it knowingly from motives of false delicacy.

A total absence of expectoration throughout the whole course of the disease, while reported, must certainly be extremely rare, and it would be most difficult to prove that it is not apparent rather than real. Formerly a typical tuberculous sputum was described, but it is now recognized that such does not exist, though certain characteristics of the sputum point to certain physical conditions in the chest. In the very early stages, when the cough first appears, sputum is often absent;

thus while 93.8 per cent of Roupke's first-stage patients coughed, only 77.8 per cent expectorated. Indeed, even considerably later we are often surprised to find that many unobserving patients do not know that they expectorate, and when it is demonstrated to them, are apt to ascribe it to a nasal catarrh, a statement which is always open to doubt until proved.

In most cases, however, even if at first absent, it soon appears, Fowler and Godlee ('98) believing that "it is rarely absent when symptoms have been present for as long a period as two months." At first there is only a little mucoid, glairy sputum, with at times dark points in it, and so full of air that it floats on the water. Every now and then some transparent, jellylike masses, usually compared to grains of boiled sago, or by Aufrecht ('05) to frogs' eggs, are brought up. These masses are composed chiefly of alveolar epithelium, either unchanged or in a stage of fatty degeneration, the result of an alveolar catarrh. The sputum slowly increases in amount, and becomes thicker and more dense and less transparent, owing to increased cellular content, and shows scattered through it yellowish-white flocculi, and while still containing enough air to float, sends down into the water long processes like streamers. The increase of formed elements changes its color to a whitish-yellow or a slightly greenish tinge, or at times to a faint pink shade. As tissue necrosis begins, the mucoid portion lessens and the purulent portion increases until it is plainly mucopurulent and greenish-yellow in color, tending to sink in water and showing the nummular masses which were once considered so diagnostic of tuberculosis. These are irregularly scalloped, rounded, grayish, or greenish-gray balls, which hang from floating islands of mucus and saliva by long strings, if not too purulent, or if so, sink to the bottom to form disk-shaped, coinlike masses, which, however, do not coalesce. While nummular sputum is not pathognomonic, as it can occur in bronchiectasis, it is fair evidence of a cavity in the lungs.

In the late stages the sputum is an evenly purulent liquid mass containing no air, and hence sinking to the bottom of the water at once, where it makes a nasty gray-green deposit in which we can find fragments of cheesy matter. In rapidly breaking down lungs the sputum contains irregular cheesy fragments, which Bayle likened to grains of boiled rice, and which he considered characteristic of tuberculosis, while the dirty, dark-gray sputum seen in this stage Aufrecht considers always the product of the cavity wall.

At first odorless, though of salty taste, it is in the late stages of a marked sweetish, nauseating odor, and sweetish sickly taste. An offensive odor is not present in uncomplicated cases of tuberculosis, but it is only found when abscess, gangrene, or bronchiectasis exist.

The amount of sputum can vary within wide limits, but in the average case, until cavity formation, it is quite moderate and by no means so profuse as in chronic bronchitis. While it may amount to a pint or more in twenty-four hours, this is rare, one or two ounces being the average, and three or four ounces being rather unusual. A convenient measure is the commonly used folded paper sputum cup in its tin frame, and patients in the early stages rarely more than cover the bottom of one of these; patients in the second stage are apt to expectorate one third or one half a cup, unless tissue destruction is very active, while old cases will fill one, two, or even three cups in twenty-four hours. An estimate of the amount of sputum in twenty-four hours should always be made, and sudden or gradual increases or decreases should be noted. A sudden decrease usually presages a congestion, a marked increase a bronchitis, a gradual increase a breaking down of hitherto only infiltrated areas, while a gradual decrease generally speaks for lessening trouble, decreased ulceration, or the drying up of a cavity, and is of unquestionable prognostic value if it persists. As the patient improves, the sputum tends to become less purulent and more white, foamy, and mucoid, and is apt to cease entirely much sooner than the cough stops.

In the case of patients with purulent sputum who take up an outdoor life in a climatic resort, there is generally noted at first an increase in quantity but an improvement in quality, the sputum becoming whiter, more mucoid and foamy, and more abundant, and only after this does it decrease in quantity as well. In examining the chests of patients who have abundant sputum, we are often surprised to find few or no signs of moisture, while often patients with many râles have little or no sputum, but generally an increase of sputum is accompanied by an increase of signs of moisture in the chest.

Ulcerative cases naturally produce much sputum of a purulent character, as do those with bronchiectasis, while acute miliary cases have none, save at times at the very end; but acute tuberculous pneumonias, while having little at first, and that mucoid, when they begin to soften and when the necrotic area is being thrown off, have an abundant sputum, which, if any gangrene be present, may be very offensive. In these cases the appearance of abundant sputum is usually a good sign, as only by a throwing off of the dead tissue can the patient possibly advance to a cure.

Fibroid cases are characterized by a scanty sputum throughout, and that mostly mucoid, or at most mucopurulent. In improving cases the bacilli disappear from the sputum in about fifty per cent, but not infrequently they will be found in every specimen until no more sputum is raised. Naturally those cases in which the sputum loses

its bacilli before it disappears may be regarded more favorably than the latter.

As to the time of day when expectoration is commonest, this, in early cases, is chiefly in the morning on rising, and during the day little or nothing will be brought up; but when the case is once well developed some sputum is brought up off and on all day, especially after eating, while in old cases most of the sputum is raised during the night, a whole cup often being filled in that time. In cases near the end no sputum may be raised, it being retained in the lung owing to extreme weakness, but if a patient is in a moderately advanced condition and is raising no sputum one should carefully investigate as to whether the sputum is not being swallowed.

When for any reason sputum is retained and not expectorated, it is usually soon followed by rise of temperature, which falls again when evacuation takes place.

Inspection of the sputum is of little value except to discover the nummular masses, sago bodies, and necrotic particles. At times one will find calcareous masses, expectorated often with severe pain. These masses originate in calcified bronchial glands or calcified foci in the apex, and since calcification is one of nature's conservative processes, they are generally considered to be of good omen. Tonsillar plugs may be found, and can be recognized by their fetid odor and by leaving a greasy mark when warmed on paper. Small specks of blood in the sputum or a pink tinging generally foreshadow a hemorrhage, but both may continue for weeks without any such results. Fibrin and blood-casts are seen occasionally, chiefly after hemorrhages.

Microscopic Examination.—While many morphologic elements can be found in the sputum by the microscope, only two are characteristic —*tubercle bacilli* and *elastic fibers*. Eosinophile cells were at one time considered by Teichmüller as a sign of resisting power on the part of the patient, but such a claim has been disproved by Turban and others. Polynuclear and mononuclear leucocytes are abundant, Löwenstein saying that tuberculous sputum consists principally of pus cells. J. W. A. Wolff asserts that polynuclear leucocytes speak for more resisting power in the patient and mononuclear leucocytes for less, but Löwenstein denies this. In this connection, it will be remembered that Arneth considers the presence of polynuclear leucocytes in the blood evidence of greater strength than when mononuclears are found.

Epithelial cells from the mouth and respiratory tract, alveolar epithelium, partly normal and partly in a state of fatty degeneration, leucocytes with pigment and myelin, which Buhl considered pathognomonic, will all be found. In city dwellers, or in those exposed to much smoke, pigment is abundant, and can even make the sputum

black, while after hemorrhage brown pigment will be found for some time. The sputum of patients moving from the center to the outskirts of a town will promptly lose in pigment content.

Before the discovery of the tubercle bacillus *elastic fibers* were more commonly sought for than at present, and it is to be regretted that their presence is now so rarely determined, as they speak unfailingly for lung-tissue destruction, and, if gangrene or abscess can be excluded, for tuberculosis, especially if pus cells are found with them. Sokolowski's work in this line in 1877 is suggestive. Of 70 cases, 19 with marked physical signs of destruction of tissue showed elastic fiber in the sputum, in 18 on the first or after repeated examinations. Of 11 cases with symptoms of destruction, but good general condition and no fever, all showed fibers. In the remaining 40, with symptoms of more or less condensation, the fibers were found in the majority. In 24 patients with only slight symptoms they were found in 8. Of the 70 patients they were present in 75 per cent. Aufrecht ('05) quotes Dettweiler and Setzer, who, in 42 cases where careful examination showed only infiltration, found fibers in 34, and in 46 with suspicion of excavation found them in 43, and in 22 with positive signs of cavity found them 22 times, or in 90 per cent of all cases. While the writer has not found elastic fibers in anything like so large a percentage of cases, it was doubtless due to lack of care and interest, and to giving greater attention to the presence of bacilli.

It is important that the profession be impressed with their real diagnostic value in the sputum. They appear, to quote Fowler ('98), as single or multiple, curled, branching, elastic fibers, forming a network, usually with traces of alveolar arrangement, and with a peculiarly sharp outline, typical of such fibers. Fox ('91) warns against mistaking vegetable fibers for elastic fibers, and says that a conclusion as to their presence could not be drawn unless there is a well-marked group of fibers, having well-defined outlines and the peculiar curves which are their chief characteristics.

Osler recommends the simple method of Andrew Clark, of pressing the sputum between two glass plates when the elastic tissue shows as gray-yellow spots, which can be picked out and examined. Sokolowski recommends Fenwick's method; 2 c.c. of water and of sodium hydrate are added to an equal amount of sputum and boiled for three or four minutes. This destroys everything except the fibers, which can then easily be gathered and examined. Other methods are mentioned in detail by Czaplewski ('91).

Elastic fibers at times are covered with a peculiar substance soluble in alkalies; they are then fairly thick, forked threads with an uneven granular surface, and are called coral fibers.

The *tubercle bacillus* is, of course, the only absolutely diagnostic sign of the disease, but unfortunately, while a positive sign, its presence being absolute proof, its absence after repeated examinations does not exclude tuberculosis. Even if all the sputum were collected, properly treated, centrifuged, and then examined, and this was kept up for a long period of time, it would be impossible to deny the possible tuberculous nature of the trouble. At the same time, while the discovery of the bacillus is necessary for absolute certainty, the physician has at his disposal many methods of physical diagnosis, and he who would wait to make his diagnosis and institute treatment until he found the organisms, would rob his patient of precious time and often throw away his only chance of cure. In cases where the sputum examination is negative and in which certainty is important, it should be repeated at very frequent intervals and with every precaution, and generally such perseverance will be rewarded.

The number of bacilli in the sputum was at one time supposed to have great prognostic value, and Gaffky made a scale of numbers corresponding to the number of bacilli in the preparation, which is still much used:

I.—One to four bacilli in whole preparation.
II.—One bacillus on average in many fields.
III.—One bacillus on average in each field.
IV.—Two to three bacilli on average in each field.
V.—Four to six bacilli on average in each field.
VI.—Seven to twelve bacilli on average in each field.
VII.—Fairly numerous on average in each field. (Brown would here put twelve to twenty-five in each field.)
VIII.—Numerous on average in many fields. (Brown would put about fifty in many fields.)
IX.—Very numerous on average in many fields. (Brown would put one hundred or more.)
X.—Enormous numbers.

However, the substitution of mere figures for a definite statement of the numbers of germs does not tend to clearness, and it would be better while using the standard given to note the exact numbers and not simply the figures. Brown's modifications seem to be a distinct improvement, but Gaffky makes too many classes between IV and VII, 2–5 and 5–10 and 10–25 being better.

While it is useful thus to record the number of germs for future reference, the conclusions to be drawn from their number are but slight, bad cases frequently showing few germs and acute cases none at all, while at times in mild cases they may be found in large numbers. As

a general rule, however, rapidly and continually increasing numbers of bacilli in the sputum speak for rapid breaking down of the tissue, and this is, therefore, a bad sign, while a gradual and continuous decrease generally goes with an improving case. Moderate and temporary fluctuations are of no value at all. If, in sputum which generally shows few bacilli, there is a small caseous mass, the preparation may be a pure culture of the germ, whereas all the succeeding specimens will show few bacilli or none.

Although they may be absent, bacilli are found in the sputum of the majority of patients. Lawrason Brown ('03) found them in 26 per cent of 76 incipient cases, in 73 per cent of 164 moderately advanced cases, and in 94 per cent of far-advanced cases. Turban found them in 38.4 per cent of his first-stage cases, 89.8 per cent of his second-stage cases, and 98.8 per cent of his third-stage cases.

No patient can be pronounced cured in whose sputum bacilli can be found, as they are the infallible evidence of an open lesion, though in a few cases patients who are clinically well will expectorate bacilli for long periods.

The tinctorial qualities of the bacillus have been supposed to give us some idea of the activity and virulence of the germ (short, darkly staining germs being supposed to come from very active cases; long, thin, beaded, faintly staining ones, the so-called degeneration forms, showing weakness), but after a good many years of sputum work I have not been able to verify such a supposition further than that severe acute cases do seem to show larger numbers of short, darkly stained bacilli and no degeneration forms. Degeneration forms, however, have no significance, as they are found in the sputum of all sorts of cases.

Position of Bacilli.—The germs are usually scattered through the fields between the cells, and where they are scanty they are more apt to be found in the streaks of mucus produced by the spreading. They occur either singly or in pairs or bundles, and when multiple show a marked tendency to lie parallel or at an acute angle to each other. At times they are found inside the leucocytes, as though phagocytosis were taking place, and in the writer's opinion this is found chiefly in severe cases, but the work of Löwenstein ('06) and Allen, of Saranac ('07), who kept careful records in many cases, does not support such a view. Löwenstein found phagocytosis in about eleven per cent of his cases, Allen in eighty-two per cent of his, the former agreeing much more nearly with the writer's experience than the latter. Löwenstein found them generally in the leucocytes with one, two, or three nuclei, which he considers the younger cells, and found them rarely in cells with four or five nuclei. He considers them commonest in very chronic cases, and in new cases tending to healing, and believes they precede a disap-

pearance of the bacilli from the sputum. Allen, on the other hand, considers them of little value in prognosis.

The *appearance of the sputum* gives no hint as to the presence or absence of bacilli. At times a mucoid, almost salivary sputum will show numerous germs, while very commonly a profuse purulent sputum will show none. Aside from tubercle bacilli one may find many other forms of bacteria, of which the pneumococcus, the streptococcus, the staphylococcus, and the influenza bacillus are the most prominent. The latter is found in the sputum in pure culture, in many cases simulating tuberculosis, Dr. F. T. Lord, of Boston ('05), having reported a number of interesting cases simulating tuberculosis which were apparently dependent purely on a chronic grip infection, the influenza bacillus being found in the pure culture for long periods. The pneumococcus in isolated instances is very common in sputum, but at times, in cases which have begun with pneumonia, it will be found in large numbers for a long time. A few streptococci or staphylococci are not at all uncommon, but in some cases the streptococcus will be found in such large numbers and so persistently, even when the sputum is properly collected and washed, as to suggest a diagnosis of mixed infection.

That such a mixed infection exists or can be proved from the persistent and abundant presence of the germ in the sputum, has been both vigorously asserted and denied. The writer believes that the process in the lung is materially affected and aggravated by the coexistence of the streptococcus with the tubercle bacillus in the areas of ulceration, and that it is responsible for many of the symptoms in the third stage. Although a mixed infection can exist and affect the course of the case, too many physicians make a diagnosis of mixed infection after finding a moderate number of streptococci in the sputum. Such an opinion should not be formed unless the germ is found in large quantities and persistently in sputum which is properly collected and handled, coming from patients with clinical evidence of pyogenic infection. The difficulties created in the urine by the smegma bacillus do not arise in the sputum, but the technic of staining the bacillus, while simple enough, demands the greatest neatness and precision in the work (see Diagnosis) if the results are to be reliable.

While anybody can find bacilli in sputum when they are abundant, it requires great skill and experience and the most precise staining methods if they are to be found in the cases where their discovery is the most important—i. e., those cases where the germ is extremely scanty.

In clinical work the *chemistry of the sputum* need not be dwelt upon, except that its organic part consists of glycogen, sugar, and albuminoid bodies derived from the white cells, especially paraglobulin, lecithin, and peptones, and that it also contains phosphates and chlorids, whose

loss through the urine in this disease has been elsewhere noted (see Urinary Symptoms). Renk has demonstrated a nitrogenous loss of 0.6 gm., which equals 4.13 gm. of albumin, or 5 per cent of the total nitrogen consumption of the consumptive. This albuminous loss, which Wanner found to be only slight in bronchitic sputum, but marked in that of tuberculosis, combined with a loss of phosphorus and the chlorids, is a severe drain on the system in old cases with abundant secreting cavities, and hastens denutrition and exhaustion.

The reaction of the sputum is usually alkaline, unless bacterial action in the cavity has produced an acid reaction, and as the differential stain fails in acid sputum, cases where a sputum examination is negative should suggest a test of its reaction, and its correction, if acid.

Hemorrhage.—So alarming a symptom as pulmonary hemorrhage compels attention, and from the days of Hippocrates has occupied a prominent place among the symptoms of this disease. The father of medicine, noticing the development of phthisis after a hemorrhage occurring in apparently healthy subjects, very naturally concluded, with the methods of investigation at his disposal, that phthisis was the result of the hemorrhage, and spoke of *phthisis ab hæmaptoë*, and the power of authority in medicine and the slow development of medical knowledge is well shown when we recall that this view, promulgated before the time of Christ, was generally accepted well into the last century, and although Laennec and Louis, of France, in the first half of the nineteenth century recognized and taught the error of this, it had so distinguished a defender as the great Niemeyer as late as 1870.

While there are various conditions which can produce a discharge of blood from the mouth, and thus simulate a pulmonary hemorrhage, as, for example, heart disease, carcinoma, hemophilia, arteriosclerosis, vicarious menstruation, hysteria, aneurysm, bleeding gums, nasal, pharyngeal, laryngeal, or gastric lesions, the great majority of all hemorrhages are dependent on tuberculosis of the lungs. In this connection the well-known statistics of Sticker as to hemorrhage in the ranks of the German army are very instructive. Of 480 cases of hemorrhages, either without known cause or following "colds," 221 were tuberculous, 196 probably so (86.6 per cent). Of 379 cases of hemorrhage resulting from overexertion in military maneuvers, gymnastics, singing, blowing wind instruments, trauma, and the like, 282, or 74.4 per cent, were tuberculous. So marked is the causal relation that Sée ('84) says, "aside from infectious diseases, hemophilia, and acute infections of the lungs (pneumonia, abscess, gangrene) . . . we only know of two real causes of hemoptysis—heart disease and pulmonary tuberculosis," and with the advance of modern diagnostic and clinical

methods it is daily more evident that in a case of pulmonary hemorrhage the evidence must be very strong to support any other diagnosis than that of tuberculosis.

The pathologic conditions antecedent to hemorrhages vary in early and late cases. In early cases several hypotheses have been advanced to explain bleedings occurring before there is destruction of tissue. A localized hyperemia of the pulmonary tissue has been suspected, and Flint ('75) cites a most suggestive case and autopsy which seems to justify this as a probable cause, and Anders ('07) considers that the influence exerted by violent or long physical exercise in the production of hemoptysis justifies this view. However, it is probable that the more ordinary cause is the weakening or erosion of small blood-vessels by the growth into them of tubercles, or, as is well put by Sée: "We must recall that the branches of the pulmonary artery are terminal branches . . . if the caliber of one of these arteries is lessened as a result, for example, of a perivascular tubercle, and protrudes into the lumen, the blood-pressure is raised at the narrow part, and a rupture follows."

The hemorrhage can only cease by the occlusion of the bleeding vessel by a thrombus filling the cavity, and until this is firm the hemorrhage will continue, hence the great need of absolute rest and quiet to favor the occlusion of the bleeding point.

Early hemorrhages are always venous, and therefore, since pulmonary venous blood is aërated, are bright red. In later stages hemorrhages arise from the vessels of the lung, usually a pulmonary artery, chiefly in cavities, and the blood is dark. The connective tissue of the advantitia being more resistant to the eroding effects of the destructive process, the blood-vessels, generally of moderate size, are dissected out and stand out in the walls of the cavity or cross it. On these unsupported vessels small saccular or fusiform aneurysms form, and, generally as a result of raised blood-pressure, burst, giving rise to the large and fatal hemorrhages of late phthisis. This method of hemorrhage production being open to demonstration by autopsy is the best established of all, but in some old cavity cases it seems probable that hemorrhage can result from the oozing of the granulations which line the walls. The relation of overexertion to the occurrence of pulmonary hemorrhage justifies the belief that a large number of cases of hemorrhage are brought about by an undue rise in blood-pressure, and every physician can remember many cases which followed the lifting of weights, straining at stool, running upstairs, etc., but, although the condition of patients just after a hemorrhage makes it difficult to study their blood-pressure carefully at such times, a large percentage of cases will show a low-tension pulse before as well as after the hemorrhage, and Otis ('07), in 18 cases at

the Rutland Sanatorium, found the pressure normal or below normal in all but one.

The frequency of hemorrhage in tuberculosis has been variously estimated between 30 per cent and 80 per cent; De Renzi ('94) gives it as one third to two thirds, Fox ('91) as 54 per cent, Aufrecht ('05) as 26.4 per cent, Williams ('87) as 57 per cent, Walsh ('71) as 81 per cent, these various estimates depending probably on the class of patients studied by the different authors. From 40 to 60 per cent would be a fair estimate. The immediate cause of hemorrhage in early cases is not always determinable; often a man in apparently perfect health and at rest will suddenly bring up a mouthful of bright, foamy blood without warning of any sort. More commonly, however, the cause is overexertion, such as athletics, lifting weights, running upstairs, straining at stool, blows on the chest, unduly hard percussion, or, in short, anything which raises blood-pressure or produces trauma. Excitement, worry, or temper can act in the same way, and the sight of one patient bleeding will not infrequently start a hemorrhage in another patient.

Barometric or other *meteorologic conditions* have an undeniable effect in producing hemorrhages, though it does not seem that this has been sufficiently dwelt on by writers on the subject. It is certain that everyone who has handled numerous cases of tuberculosis has often been struck with the occurrence of several cases of hemorrhage within a day or so, and ascribable apparently only to weather conditions.

While the writer has not made a close study of meteorology, he has noticed that close, damp, hot spells with a low barometer seem to be the time when many cases of hemorrhages are apt to occur, and that this bunching is much less common in winter. Thus, in the practice of Dr. W. L. Dunn, in the summer of 1907, sixteen hemorrhages occurred among his patients in one week. While it is impossible at present to prove such a causal relation, it is certain that the majority of clinicians have noted such an effect of weather conditions.

The *premenstrual period*, during which there is a systemic plethora, has a distinct effect in producing hemorrhage, and female patients of a hemorrhagic tendency come to dread this time. In patients who have ceased to menstruate, any undue susceptibility to hemorrhage has not been noted, but instances of vicarious hemorrhage as a substitute for a missed menstrual period or cured bleeding hemorrhoids are on record.

In patients whose *appetite* is very large, and in whom a condition of plethora is created by hypernutrition and rest, not at all a rare thing in sanatoria, it has seemed that hemorrhage is more common than in others less fully nourished; those patients who have fattened and become ruddy rapidly under outdoor treatment quite frequently show some bleeding.

If *sex* has any influence on hemorrhage, as Louis taught, it is not very great, although there is a slight preponderance of hemorrhages in women. Anders ('07), in 589 cases, found that liability to hemorrhage appeared at an earlier period in women than in men.

There does not seem to be any special *time of the day* which favors the occurrence of hemorrhage, though the disturbance of the doctor's sleep by night hemorrhages is apt to cause him to think them more common in the night time. The *season* of the year has a distinct influence. In the writer's experience the spring months show a preponderance of hemorrhages, and as this is the time when a tuberculous patient is best nourished, it may possibly be explainable on the grounds of plethora. Thompson ('79) considers them commonest in the summer heat, and Anders ('07) found them most common in the spring and summer months, and ascribed them to the enervating effects of heat and the influence of marked oscillations of heat and humidity during the spring months, but Gabrilowitsch ('99), in Finland, found hemorrhages most frequent in March and October, and none occurring between April and July.

Heredity, according to Fox ('91), plays some part, those of his patients who had a marked family history of tuberculosis showing a greater tendency to hemorrhage.

Age has a marked influence, hemorrhages being extremely rare in infancy and uncommon in childhood, and increasing in frequency with puberty, most common between twenty and twenty-five, and after forty-five becoming less common. They are rare in old age. Of Aufrecht's cases ('05), forty per cent were between twenty and twenty-five, and 83 of Anders's 197 cases were between twenty and thirty, and 62 between thirty and forty ('07).

The *stage of the trouble* bears some relation to the frequency of hemorrhage. It may be an initial symptom, nine per cent of Reiche's cases being of this sort; in abortive cases it is often the only symptom. While it may occur at any time during the course of the disease, the writer has found hemorrhage most common in relatively advanced cases, and Fox ('91) agrees with this view, but quotes the first Brompton report, in which seventy-two per cent of the hemorrhages occurred before softening, and Williams also believes that the first hemorrhage is apt to occur early in the trouble. Thompson ('79) considers bleeding most frequent in the second stage, with ulceration, 437 out of 1,000 of his cases occurring at this time. Possibly, however, careful inquiry into the past history of the patient might reveal previous slight hemorrhages in many cases seen first in a more advanced state.

Fatigue is a common cause, possibly because fatigue generally implies

overexertion and raised blood-pressure; certainly hemorrhages seem to be very common during or just after long railway journeys.

Clinical Picture.—Quite frequently a hemorrhage is preceded by no warning symptom; the patient suddenly feels something in his throat, spits it up, and is horrified to find that it is blood. More generally, however, there is a pricking in the throat, a short cough, a salty taste in the mouth, a sense of weight and oppression or tightness in the chest, while not infrequently there will be a sore spot in the lung for a few days preceding a hemorrhage, or a feeling of tightness, pain, and oppression, and many patients can predict a hemorrhage which the doctor is far from anticipating, so that physicians should never neglect any such "feelings" on the part of their patients.

A premonitory streaking of the sputum with traces of blood will, in moderately advanced cases, often precede the bleeding for some days, and gives us useful warning, for blistering over the site of congestion will unquestionably have good effect in some of these cases. The amount of blood lost may vary from a slight streaking of the sputum, or a faint, pinkish staining to any degree of mixed sputum and blood, up to mouthfuls of pure blood; but a hemorrhage does not generally exceed one half to one pint, though in old cavity cases enough blood may come up to kill the patient at once by syncope.

A correct estimate of the quantity is difficult, if not impossible, the patient and his friends generally being terrified, the blood often being received into water in a basin or slop jar, and increased in bulk by frothiness and greatly magnified by alarm. However, while a single hemorrhage is rarely as large as a patient supposes, the repetitions can bring the amount lost in twenty-four hours up to a quart or more, and it is surprising what large amounts patients can continue to lose, day after day, without succumbing. Smirnow recently ('07) reported a case in which ninety-seven ounces, by careful measurement, were lost in three days, the patient recovering. The majority of hemorrhages are probably less than one ounce, the figure given by West ('02).

The *color* of the blood in early cases is bright red, and is at this time generally combined with air, so as to be foamy, and is mixed with much saliva and sputum. In advanced cases it can come up in gurgling gulps, and is darker, since it comes from the arteries, and by clotting in the larger bronchi often produces severe dyspnea. If the hemorrhage lasts for some days the later blood is clotted and dark, but should not easily be mistaken for stomach blood. By degrees the blood clots lessen, sputum begins to reappear, although at first badly blood-stained. Gradually, however, it resumes its normal color, and in a few days, if the hemorrhage does not repeat itself, no more traces can be found. When pneumonia supervenes, there occurs, generally on the third or fourth

day, a sudden extreme rise of temperature, which continues without remission until it clears up, but if dissemination follows the pneumonia, the temperature persists. The temperature gives no warning of impending hemorrhage, but, except in very slight cases, rises moderately within a few hours after its occurrence. If the loss of blood is very large, there will occasionally be a drop of temperature, but within the first twelve to twenty-fours hours there will always be a rise, which, if no complications develop, gradually disappears.

The *physical signs* of hemorrhage are very unsatisfactory. The most careful auscultation may fail to show the site of the bleeding, and in early hemorrhages the most thorough examination will often fail to show any signs of pulmonary trouble, so that the absence of demonstrable lesions should never lead one to declare that a hemorrhage did not come from the lungs.

If the process is already known to exist in the lung, it may even then be impossible to find any signs of effused blood, though generally one will find large or medium moist râles in the sternoclavicular angle, or second or third interspace, on the affected side, gradually diminishing downward and not infrequently discoverable at the base as well. This, however, does not justify a statement that the blood originated at the point where the râles are heard, as the fluidity of the blood allows it to travel rapidly, so that not infrequently one can get moisture on the sound side; but unless the hemorrhage be followed by rapid dissemination, the moisture disappears in two or three days.

In hemorrhages of any considerable size the information to be gained by physical examination is too slight to justify one in favoring a recurrence of bleeding by the necessary manipulations of a physical examination. Percussion should in no case be made, and except for a light auscultation of the easily accessible anterior thorax the lungs should not be examined until the sputum begins to clear up.

Hemorrhages may be single and never recur, and every physician at times gets histories of such cases. These are the "abortive cases," which, until recent years, have been overlooked, but where autopsies long afterwards show old healed tuberculous foci. A gentleman, now nearly sixty years of age, while a slender boy of sixteen was rather run down and below par, and had a slight hemorrhage, for which he was sent to the country for a year, and has ever since lived in a large city in perfect health. If, however, a close study were made of many of these patients in their after life, a number would show the development of tuberculosis at a later date. Such a case is reported by Sée ('84). An Italian gentleman, who had a hemorrhage at twenty-one, was perfectly well until forty-four, when he developed a cough and showed signs of apical tuberculosis. Unfortunately, many of these patients do

not consult a doctor, or if they do they are too often assured, after a superficial examination, that the bleeding was of no importance, and go away with a dangerous sense of security.

Such patients may either be in perfect health at the time or be somewhat "run down and below par," with possibly a slight cough. In any case, all such should be considered tentatively tuberculous, and every diagnostic measure be used to reach certainty, and if a diagnosis cannot be made, the after course of the patient should be followed with care.

There is another class of patients in which but one hemorrhage occurs, where one large hemorrhage is followed by the development of an acute bronchopneumonic phthisis from a general dissemination of bacilli through the lung by the blood, which at times shows the germ abundantly. Such are the cases developing unexpectedly in unusually athletic young men, in the midst of perfect health, and usually going on to a rapidly fatal ending. The large majority of tuberculous hemorrhages, however, are sure to recur at some more or less remote time, though if one could get statistics of all the cases referred to above in which there was one hemorrhage, the trouble then aborting, this majority would doubtless be greatly reduced.

After a hemorrhage begins most patients will have several blood-spittings during the next few days, and in not too incipient cases the blood-spitting may occur several times a day for as much as six weeks, and yet be followed by improvement, and it is surprising to see what large amounts of blood a patient can lose without suffering more than a slight anemia, and with final recovery.

The *nervous system*, even in the most phlegmatic, undergoes a great shock at the first one or two hemorrhages, but familiarity breeds contempt, and after a few recurrences a patient looks upon a hemorrhage with remarkable coolness.

Recurrences may be either at long intervals, generally accompanied by a relatively favorable condition in the interim, or there may be a rapidly repeating series of hemorrhages producing an acute dissemination, hastening a fatal termination, or producing a severe and fatal anemia. Such patients continue to bleed, with short intermissions of a day or so, for two months, gradually losing strength, becoming anemic, and wasting till life is ended. In these cases it is impossible to decide, if there are no great signs of spread of the trouble, whether the patient can finally check the bleeding and recover or not, and the doctor and family are kept alternately between hope and despair for weeks.

Where large cavities do not exist, frequently recurring hemorrhages speak for a rapidly disseminating process in the lungs, with the formation of tubercle and destruction of tissue. In old cavity cases there may be long periods in which the patient brings up gray cavity sputum,

evenly stained pink, owing to the oozing of blood from the granulations lining the cavity, and such pink sputum often precedes a hemorrhage.

The *results* of hemorrhage are much less severe than the alarming nature of the symptoms would lead one to expect. In early cases the immediate results are generally negative, the patient feeling no change of any sort in his condition, barring the nervous shock. In rather more advanced cases the patient, relieved of a sense of tightness and oppression in his chest, the pain removed, and his trying dry cough changed to an easy, loose one, feels in every way much better, and not a few such cases are not only thus subjectively improved, but date their recovery from the beginning of the hemorrhage. Whether this is due to a germicidal or antitoxic effect of the blood serum which floods the lung, or not, is unknown, but apparently the local action of the blood on the lung can be favorable, unless it serves to spread bacteria through its tissues. At one time it was held by Niemeyer that the blood, by its presence in the lungs, produced an inflammation harmful in itself, and precedent to tuberculosis, but experiments (Sée) have shown that pure blood, free from germs, can be injected into the lung and absorbed there without any inflammatory effects. Flint ('75) noted more recoveries in his hemorrhagic cases than in those not having hemorrhages, and believed that in the majority of cases their effect was good. This can, in some degree, be ascribed to the fact that so alarming a symptom is apt to make even the most heedless patient careful and obedient so that better results can be gotten from his case.

In very advanced cavity cases, however, the effects of hemorrhage are generally disastrous, even where the bleeding is not sufficient to kill at once, which is the end in a certain number of cases. Cornet ('07) quotes Brehmer, Wolff, and Stricker, who found 0.15 per cent of such sudden deaths in pulmonary hemorrhage.

A typical instance was that of a middle-aged lady, who had advanced and incurable phthisis, with a large excavation in the left lung, and who wintered in Asheville for several years with great comfort, though without any prospect of cure. Without having had premonitory symptoms of any kind, she awoke one morning at the usual hour, sat up in bed, and began to speak to her sister across the room, when suddenly a flood of blood burst from her mouth and she fell back dead, doubtless from cerebral anemia and syncope. Such an end is painless and instantaneous; but, on the other hand, death by suffocation from a large hemorrhage is very painful; the air hunger, the gurgling blood in the throat, the spasmodic efforts at breathing, and blood over everything, making a terrible and never-to-be-forgotten picture, which, fortunately, is not common. At times only a little blood appears at the lips, most of it being retained in the cavity and the bronchi. The result, however, is

equally fatal. While sudden death of this type is rare, the more remote dangers, exsanguination, exhaustion, and pneumonia, with or without acute softening and dissemination of the process, are more common.

The following case is a good example of pneumonia, with rapid dissemination:

A gentleman of middle age, with a very small cavity, nearly dry and shrinking, who apparently was going on toward a satisfactory arrest of his trouble, and who had almost no symptoms of any sort, began to show slight blood streakings in his sputum, which rapidly increased to copious discharges, continuing for several days, and due probably to the erosion of a small miliary aneurysm. Suddenly the temperature went up, pneumonia developed, followed by rapid acute softening, and the man was dead in ten days.

In all hemorrhagic cases a sudden, undue rise of temperature on the second or third day should excite suspicion of *pneumonia.* If pneumonia develops, the temperature will continue high, pains in the side, though not always present, will generally develop, and physical signs appear. Such a pneumonia may be either a bronchopneumonia or a lobar pneumonia due to the pneumococcus which is present in the lungs, and which is probably stimulated to grow by the blood serum thrown out, and from these the patient often recovers very well; or it may be an acute tuberculous pneumonia, due to the bacillus, which has a uniformly fatal termination. Again, the fatal result may be due to exhaustion and to exsanguination. Such a case was that of a young man recently brought from Colorado Springs to Asheville on account of frequently recurring hemorrhages. He at first seemed to improve a little, but after a few weeks the hemorrhages began to recur again, and he would have a number of small or moderate-sized ones during several days, with free intervals of several days between. No marked dissemination occurred, but although he lost no very large quantity of blood at any one time, the steady drain on his blood-making organs and on his vitality was too great; he grew paler and paler, and more and more exhausted, and finally died from these causes alone.

Quite a frequent result of hemorrhage is a moderate degree of dissemination of trouble into hitherto healthy surrounding areas, and it is, therefore, necessary to make a most careful examination when the patient has recovered from the bleeding to see if any such dissemination has occurred.

The *diagnosis* in most cases is easy, but at times is accompanied by considerable difficulty. It is too commonly the habit of the profession to say that a slight hemorrhage came from the nose or the throat in order to quiet anxiety, a practice that cannot be condemned too emphatically. Even the most nervous patient can tactfully be made to realize to what

the hemorrhage is due without being unduly alarmed; and even were it impossible not to alarm the patient, it would be much more desirable to do so than to keep him in ignorance of the truth, when that ignorance so often means loss of the best chance of recovery.

In certain patients the possibility of hysterical blood-spitting must be kept in mind, and one should be certain that the patient is not producing blood in order to create sympathy. A few people can unconsciously, in their sleep, suck their gums, and if these are unhealthy they can wake up to find bloody saliva in their mouths, but here, again, careful examination should remove any difficulty. In doubtful cases, the nose, mouth, throat, and larynx should be examined carefully under the most favorable conditions to exclude possible broken blood-vessels in these regions; the heart should be gone over carefully to exclude mitral stenosis or any other cardiac conditions antecedent to hemorrhage. Babcock would distinguish blood coming from above the glottis by the fact that it is not accompanied by cough, while he believes that pulmonary hemorrhage invariably is accompanied by cough.

If there is any doubt as to a possible hematemesis, the expectorated blood should be examined ocularly and microscopically and as to its reaction, especially as quite often after hemorrhage patients will vomit blood which came from the lungs and was swallowed. But hematemesis can at times present insuperable difficulties of diagnosis, so keen an observer as Graves having said: "You are told gravely that you can distinguish blood discharged from the stomach from that which is discharged from the lungs by the differences of its color and consistence, and the presence or absence of air bubbles. No, gentlemen, you cannot."

In some cases it is possible to get a previous history of tender spots in the stomach, hyperchlorhydria, dyspepsia, etc., but where blood comes from a gastric varix, or from an aneurysm of the pulmonary artery, a diagnosis is impossible. Theoretically, stomach blood should be unmixed with air, and acid in reaction, if not too abundant; one should also be able to find food remains, and it should be followed by tarry stools, etc., but such distinctions, while very easy to note, are by no means always as easy to discover clinically. The brightness of color of the blood is of no assistance, blood from the lungs, if from a pulmonary vein or bronchial artery, being bright red instead of dark.

Hemorrhage due to heart disease should not give trouble to anyone habituated to carefully going over every detail of his case, but not infrequently a diagnosis of tuberculosis of the lungs is made when mitral stenosis alone exists.

Hemorrhage from a nontuberculous lung—a vicarious menstruation—is on record. The writer has never seen such a case, nor a purely

hysterical hemorrhage, although several authentic cases are on record. It must present great difficulties of diagnosis. However, it cannot too often be insisted on that while one should not jump to the conclusion that every hemorrhage is an evidence of pulmonary tuberculosis, he should be very slow to make a diagnosis of nontuberculous hemorrhage, and should use every possible means at his disposal before accepting it.

Pain.—Pain, while not a very valuable symptom in phthisis, is often a very early one. De Renzi ('94) claims that it is present in two thirds of all early cases, and Peter considered it a valuable early diagnostic sign. The writer does not consider it a sign of great value, nor has he found it present in so large a percentage of cases, but it is fairly frequent, and combined with other findings can at times be an aid in diagnosis. As a rule, the pain is not very intense, but it is fairly constant, is apt to be increased by coughing, and later in the disease generally disappears. It is usually a dull aching or boring pain, most common in the supraclavicular fossa or in the supraspinous fossa, in which last location it often is manifested as a burning spot, which is probably due to an apical pleurisy with adhesions forming.

At times quite a sharp neuralgic pain will be felt in the point of the shoulder, in front, with each cough or with much motion of the arm. When in the shoulder the pain is often mistaken for rheumatism, and patients have been known to visit a well-known hydropathic institution to be treated for some time on a diagnosis of rheumatism, the real trouble not being discovered until the patient left the institution. This early apical pain can be relieved by the application of small fly blisters. It may precede for months the appearance of a demonstrable lesion. The writer has known one of the best diagnosticians of this trouble in the country to be unable, on the most thorough examination, to find any trouble at the site of such a pain, although considerably later a lesion appeared there. Therefore, even in the absence of physical signs, such pain, if persistent, can be regarded as very suspicious and should cause one to follow the case with care.

At this stage pain on pressure or percussion is not common, but a little later, when the process is more pronounced, pain on percussion, especially above the spine of the scapula, and between it and the vertebræ, or over the site of congestions or cavities, is very common, and over cavities will generally persist. An infiltrated apex will often produce a general sense of soreness and aching in the upper part of one side of the chest which may be very trying. Again, very often active motion will produce severe lancinating pains in the apex, due to traction on apical adhesions, and violent exercise, such as riding a hard trotting horse, may produce very severe paroxysms of such pain.

As a rule, the pain in the lungs in tuberculosis, even if it persists, is not constant, being present only at intervals, especially when the patient has overexerted himself in some way. A dull aching pain between the shoulder blades is common and very fatiguing, but the writer has never seen the severe insistent and intolerable pain in this region, demanding morphin for its relief, referred to by Aufrecht ('05).

More common in this stage is a general aching of a large area of the affected lung, with a drawn, tight feeling. The patient is aware that he has a lung, and feels that it is bound down and cannot expand. Localized pleurisies generally manifest themselves by sharp, sticking pains, increased by pressure in the intercostal spaces; but it is strange how seldom in tuberculosis one finds frictions over the site of undoubted pleuritic pains, while very often large areas of plain pleuritic friction with no pain at all are discovered.

The distinction of pleuritic pains from intercostal neuralgia is at times difficult, but generally the latter can be demonstrated by following the intercostal space to the spine, finding tenderness all along, and especially tenderness over the nerve root. Pleurisy of the lower anterior chest will manifest itself at times by referred pain in the abdomen, and thus subdiaphragmatic pain in the tuberculous should call for careful examination of the lower thorax, as Fowler ('98) points out. Not infrequently patients will complain of pain in the heart region, which is due to pericardial pleural adhesions. In the later stages of tuberculosis pain is not so common, except on percussion, and it is apt to be in the lower portions of the lungs, owing to spread of superficial pleurisy, which is accompanied by pain at the base of the lungs and a feeling of constriction.

In advanced cases, with severe coughing, the abdominal muscles and the insertion of the diaphragm may become exceedingly tender, so as to cause the patient a great deal of suffering. Very usually in such cases the sites of cavities are tender on pressure, and quite frequently, preceding a hemorrhage, patients will complain of a dull ache in these spots.

In speaking of the nervous manifestations of tuberculosis, reference has already been made to the great frequency in neurotic, and more especially Jewish, patients of fleeting thoracic pains, of nervous origin, appearing and disappearing irregularly in various parts of the chest, but I have never been able to determine any connection between them and any pulmonary change, or that they have any bearing, favorable or unfavorable, on the course of the disease. The severest pain in phthisis is that accompanying and following the occurrence of a pneumothorax. This can be so severe and agonizing as scarcely to yield to morphin, and lasts for a number of days.

OBJECTIVE SIGNS

Inspection.—Form of Chest.—In incipient cases the chest does not usually show any marked changes from the normal, and many, if not a majority, of such patients have a good general build and a well-shaped chest, the paralytic thorax once considered so typical being found in only a very few incipient cases whose development it antedates, though it is common in the advanced stages of the disease. Aufrecht ('05), however, notes that the real paralytic thorax differs from the thorax seen in cases of advanced tuberculosis in that in the latter the chest falls in, while in the former it sinks down.

The frequency of well-formed chests in early cases will be recognized when it is recalled that Alison ('61), after the examination of 6,000 chests at the Consumption Hospital at Brompton, found "comparatively few distorted chests among phthisical patients—not more, in proportion, than are found in persons not suffering from phthisis," and that Brown and Pope ('04 B) found 83 per cent of well-formed chests in 193 incipient cases, while Serailler (Herard, etc., '88, p. 497) in 60 cases of all stages found 28 normal chests, and concluded that "more than one half of all the phthisical have a regularly formed chest."

The *paralytic thorax*, when seen, speaks for a pronounced hereditary taint, and in this stage undoubtedly antedates tuberculosis and is not a result of it. The chest is long, narrow, and apparently flat, the sternum flat, the clavicles and scapulæ prominent, the angle narrow, the ribs oblique and their interspaces wide, the skin delicate and semi-transparent, the hair fine and silky and often red blonde (Figs. 36 to 38).

Woods Hutchinson ('03) maintains that the shape of the tuberculous thorax is not always really flat, but often only apparently so, and as a result of his studies he claims that instead of being generally flat, as was formerly thought, it is unusually round, the antero-posterior diameter being about 80 per cent of the transverse instead of 68 per cent, which he considers the normal thoracic index. This he believes to be a persistence of the infantile type of thorax, and the discovery of an index of 80 or more in a person over eighteen years of age he believes raises a strong suspicion of tuberculosis.

Bessensen ('05) accepts these views and considers that phthisical chests show an arrest of the development of the transverse diameter which should follow puberty. Brown and Pope ('04 B), in a careful review of the subject, and as a result of the study of a large series of cases from various sources come to different conclusions. They found the normal in-

dex to be 73, that in early tuberculosis 72, and in advanced cases 76, and while they believed that the advance of the disease tends to increase the index, they consider that this needs confirmation. They found that these cases tended to show two types, one with a flat chest, with a low index of 68 to 70, and one, deep and round, with an index of 78 to 80, *but both reduced in size.* This agrees with the conclusions of Joffres and Maurel ('05), who consider the index variable, but the perimeter and thoracic section always lessened. According to these authors

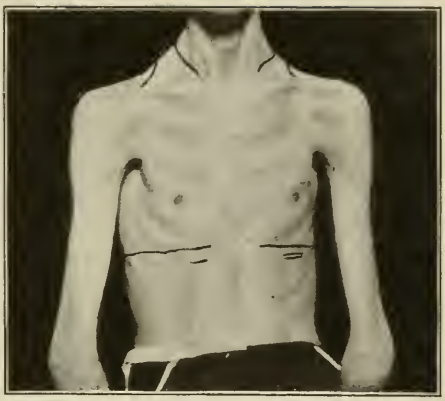


FIG. 36.

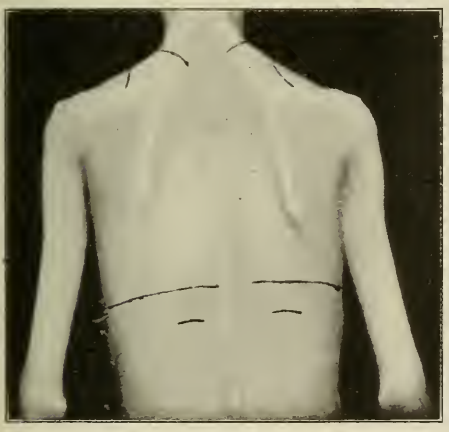


FIG. 37.

FIGS. 36 TO 38. — RAPIDLY DESTRUCTIVE PROCESS OF BUT SIX WEEKS' DURATION, BUT RESEMBLING AN ADVANCED CHRONIC CASE. Note typical lateral view. Note change of left apical resonant area. Extensive cavities in both lungs.

there should be 8 sq. cm. of thoracic section for each kilo of body weight. Bezançon also ('06) concludes that the transverse diameter is more developed than the antero-posterior, which is generally lessened, and considers that there are two types—the flattened chest, which he connects with the usual form of chronic tuberculosis, and the globular, which he considers commonest in tuberculosis with emphysema.

FIG. 38.

The writer has for a number of years taken cyrtometer tracings of the chests of all his patients at the level of the fourth costal cartilage at the sternum in front and of the eighth dorsal spine behind, and while he has not estimated the index of all of these outlines, he, like the authors quoted, has not noted any such preponderance of narrow, deep chests as Hutchinson reports, and, indeed, in the very advanced cases he has found a large number of very flat, broad chests, with an outline suggesting that of a kidney bean, which agrees with tracings given by Kuhn ('99). Since, however, as Brown ('04 A) has shown very slight differences in level make great differences in the index, this question cannot be finally settled until all observers agree on and use the same points in taking their measurements.

The writer is certain, as a result of the study of very many tracings, that the unduly flat chest is rare in early tuberculosis, but common in late cases, and that as the disease improves, the thorax, with few exceptions, becomes deeper as well as wider, and that if the patient does badly the opposite tends to occur.

As to the relation of the perimeter to the height of the patient, all observers agree that it tends to be less than one half, and that a thorax showing such a decreased perimeter measurement is suspicious.

At times one finds patients who present a typical barrel-shaped emphysematous chest, chiefly middle-aged or old men, the emphysema antedating the tuberculosis for years. In these cases the course is usually favorable, but the diagnosis is apt to be rendered difficult by the emphysema of the lung tissue, the shape of the thorax, and the asthmatic breath sounds so often present in such cases which mask the signs of tuberculosis.

While the presence of tuberculosis in the chest produces in the beginning but slight changes in the general form of the thorax, it is responsible for various small alterations which can be found on careful inspection and which are of great value in the diagnosis of the disease. The most important of these early changes are alterations, first in the outline in the upper border of the chest between the neck and tip of the shoulder, and then in the supraclavicular fossa and clavicle. These depend on a lessened functional activity of the lungs, with the accompanying lessened volume of the organ, and, somewhat later, on retraction of the apex and wasting of the shoulder-girdle muscles.

These changes are: first, a slight shoulder droop, the point of the shoulder on the affected side being from half an inch to an inch lower than that on the good side; second, a slight flattening or a very slight hollowing of the supraclavicular fossa; third, a retardation or limitation of the motion of the affected side; and fourth, a slight flattening of the

muscular outline of the shoulder, owing to a wasting of the trapezius.

The shoulder droop is found very early, and is present in a majority of cases, but in those who, like clerks, have worked much at desks, it can be simulated by the lifting of one shoulder which this produces and which leads to the belief that the other shoulder is lowered. The acromial end

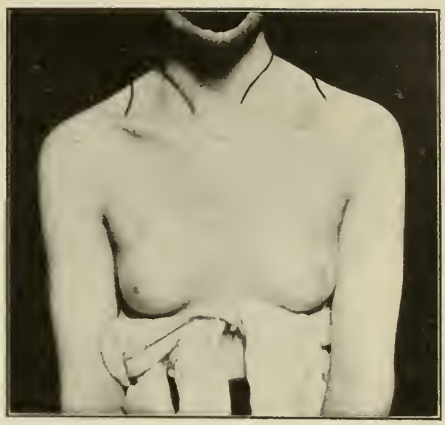


Fig. 39.

Fig. 40.

Figs. 39 to 41.—Shows Chest Outlines and Limitations of Resonant Area, Right Shoulder Droop. Prominence of right clavicle and hollowing below it.

of the clavicle is likewise lowered, a point on which Aufrecht ('05) lays especial stress, but which has the same significance as the shoulder droop, and goes hand in hand with it. The supraclavicular fossa, which in health is usually slightly convex, is flattened or even very slightly hollowed, and the clavicle is usually slightly more prominent on the affected side, and rarely, except in those who have been used to hard manual labor, is there any prominence on the good side such as Brown ('04 A) has noted. The flattening of the supraclavicular fossa at this time is due solely

Fig. 41.

to the shrinkage of the lung which comes with the lessened function produced by the disease, the lung having been shown to change in volume quite rapidly, with increased or decreased functional activity (Le Grange). Such flattening in very early cases is not due to fibrosis or to the shrinkage of pleural adhesions which in later cases is responsible for it. This early flattening or hollowing the writer has again and again found to disappear if the process is arrested and cured, while in advanced cases the greater hollowings which occur can be compensated for or replaced by an actual convexity, if much emphysema develops. The infraclavicular fossa does not usually show much hollowing in the early cases, though sometimes the hollowing will be here and not above the clavicle.

Motility of Chest.—Retardation or limitation of motion are very early signs, and combined with shoulder droop and supraclavicular flattening justify a strong suspicion of apical involvement. In retardation the lung starts to expand and the shoulder to rise more slowly than the other, it seems to move in jerks, and does not reach its full expansion and elevation as soon as the other. In limitation of motion, on the contrary, while not starting later, it never expands fully, and such limitation can vary from a very slight degree in early cases to absolute immobility in cases of extensive trouble. Brown ('04 A) finds limitation of motion at the apex often accompanied by exaggerated motion at the base.

In looking for changes of motion, one should distinguish between the vertical raising of the chest, which is best seen by watching the shoulders and clavicles or scapulæ from in front or behind the patient, and the expansion of the chest, which takes place from behind forward, and is best observed from behind and above the patient, with head bent forward, looking down the front of the two sides of the chest. Some limitation or retardation of motion will be noticed in a large majority of all early cases, and when it is not made out by inspection it can often be found by palpation. However, in cases with a healed lesion at one apex and a new process developing at the other, any of these signs may be more pronounced on the side of the old lesion and thus deceive. Occasionally there is retardation on the apparently unaffected side, but where this condition exists, one should examine very carefully for signs of an old healed lesion and for a history of past trouble on that side.

As the process advances, these signs all become more pronounced, the infraclavicular and supraclavicular fossa show marked hollowing, the clavicle stands out like an arch, the shoulder droop becomes very pronounced, the shoulder muscles waste, and respiratory motion becomes more and more limited. The angle of Louis, between the manubrium

and the gladiolus, tends to obliterate, decreasing from a normal of 16 degrees to anything between 8 and 0 degrees. As Alison ('61) says: "The sternum, instead of presenting a projecting line as it descends, tends to become perpendicular, or it may even incline inward as it passes down." D. Rothschild ('07) has pointed out that this flattening can at times be hidden by the formation of an exostosis at this point running transversely across the bone and simulating a prominent angle.

Fig. 42.

At times enlarged bronchial glands can cause a buckling forward of the upper sternum at the junction of the body and the manubrium, and in one case, presumably cancer of these glands, the writer has seen this occur very rapidly and produce great deformity.

With a sinking of the sternum, the angle which the ribs make with the vertical line becomes more acute. The affected side begins to flatten, at first in its upper third and then more generally, and loses its normal convexity, and this may increase until all of one side of the chest is flat and smaller than the other, with inward dislocation of the nipple in front and of the angle of the scapula behind.

Fig. 43.

Figs. 42 and 43.—Prominent Angle of Louis and Funnel Below It.

Distortion of the thorax, which is unusual in incipient cases, is quite commonly met with in the chronic forms of advanced tuberculosis, but acute cases run their whole course without any change occurring in the shape of the chest, and in these cases one is frequently struck with the finely shaped chests one sees in people with severe trouble and hopeless outlook.

The distortions of advanced cases are of two sorts, local and general. Local distortions are either manifestations of alterations in the underlying lung, such as fibrosis, pleural adhesions, or cavitation, or of scoliosis or rachitis. In marked fibrosis the shrinkage can cause numerous variations in the shape of the chest, more commonly manifested as bulgings of the ribs at the costochondral junctions, especially of the second and third ribs on the right. An old pleurisy may cause severe contractions which may draw the whole trunk over to the affected side, shortening that side of the chest. Over old superficial cavities in the upper third of the chest, saucerlike depressions are often seen, and since cavities are commonest in the upper third of the left lung, these hollows are usually seen to the left of the upper portion of the sternum.

Scoliosis, if looked for carefully, will be found present in slight degree in a considerable number of early cases (Brown found it in 22 of 103 cases). It causes, if marked, a bulging of the posterolateral aspect of the ribs on the side of the convexity. This bulging is especially well demonstrated by the cyrtometer, and if not recognized may confuse the percussion findings, such bulgings producing relative dullness. Such scolioses are generally single and usually in the lower dorsal regions, but they are at times double in the dorsal and lumbar regions. If the patient does well they will disappear as health returns. Kyphosis is seen but rarely.

Rickets is responsible for alterations in the shape of the lower portion of the thorax, chiefly along the insertion of the diaphragm, where its results are seen as Harrison's groove, a transverse hollow across the chest at this level. The intercostal angle, which should be nearly a right angle, is often more acute than normal, and in those with a paralytic thorax and in old cases of tuberculosis, may become so narrow that the free borders of the ribs are parallel with each other and almost touching for two or three inches downward from the ensiform cartilage.

The funnel chest ("Trichterbrust" or "Schusterbrust") is seen quite commonly in moderately advanced and advanced cases, but pronounced degrees are rare. In this deformity the sternum and neighboring costal cartilages are drawn inward to form a somewhat funnel-shaped depression in the center of the chest, this depression being commonest between the fourth rib and the ensiform, though it may occur at any portion of the sternum. In extreme cases the costal angle is drawn inward along with the ensiform. These funnel-shaped depressions are probably the result of obstruction to the entrance of air into the larynx in childhood, while the bones are soft by reason of rickets, but may be congenital. The writer has seen an identical deformity of this sort in a brother and sister, the thorax of one being an exact reproduction of that of the other (Fig. 42).

The *scapulæ* show no change of position until the process is well pronounced, except the dislocation inward which, as already noted, occurs when the side is shrunken, but after this time there is apt to develop a slight degree of prominence of the angle on the affected side, and as the disease advances this becomes more and more marked, the angle rotating outward and getting more and more prominent until it looks like a wing, hence the term "alar." Except for those slight changes in the shoulder-girdle muscles spoken of earlier, there is no alteration in the muscles until the process is far enough advanced for atrophy to occur, though in patients with a paralytic thorax the muscles are apt to be relaxed and flabby. In cases with much activity there may be a local wasting of the muscles over the focus of the trouble or over a cavity, and Desplatz (De Renzi, '94) even considers most of the deformities of the chest due to the wasting of the muscles.

The skin of the chest, in rapidly advancing cases or where there is much wasting, shares in the general malnutrition and is pale and atrophic; in the incipient cases it may not offer any unusual aspect. The dilated superficial veins seen on some chests, S. West ('02) considers evidence of pleural adhesions, a view shared by K. Francke ('07), who attributes to the fine vascular areas over the apices diagnostic significance in early tuberculosis. In women the breast on the side of the trouble is apt to be smaller than that of the other, but the difference in the size of the areola, noted by some Italian observers, the writer has not seen. The apex beat, if fibrosis is marked, is dislocated, and when the upper portion of the left lung is retracted from this cause pulsation can be seen over the pulmonary valve.

The *facies* is unaltered in early cases, except that the cheek of the affected side flushes on exertion or excitement, which foreruns the development of a more pronounced hectic flush. The pupil of one side or the other is frequently dilated, but not always on the side of the lesion, as has been asserted. In cases of young people with severe trouble of an active nature, the writer has frequently noted a dilatation of both pupils, and has found it to be of a bad prognostic significance.

The inspection of the mouths of patients should not be omitted, as good *teeth* are necessary to good digestion, and the teeth of the tuberculous are often in very bad shape, and are a handicap to progress. Thompson's red line along the gums is not present in many early cases, though often in advanced ones. The *tongue*, as is natural in a disease where dyspepsia is so often present, often shows some slight degree of coating and it is pale and flabby, while in old cases with intestinal lesions or severe gastritis it is fiery red and shiny. Ulcers of the tongue are rare.

Follicular *pharyngitis,* or pharyngitis sicca, is quite common, the latter chiefly in old cases.

Palpation.—Although not of the greatest value, palpation at times gives useful information, so that it should not be omitted. It gives evidence of respiratory expansion, of alterations in the conducting power of the lung tissue by vocal fremitus, demonstrates frictions, reveals painful pressure points, the location of the heart beat, and enlarged cervical or abdominal glands.

As a method of determining respiratory motion, it is frequently superior to inspection. The finger tips, laid over the apices or sides of the lung, will note very slight differences in expansion, and inspection findings, if uncertain, should always be tested by this method. The determination of vocal fremitus has only a restricted value; useless in incipiency and too varied to be interpreted in the third stage, it is only in the end of the first and in the second stage that it is of use. The vibrations of the upper right lung being normally much stronger than that of the left, an increase at the right apex must be very pronounced to make certain that it is pathologic, although such an increase at the left apex is suggestive. Slight changes at the left can be assumed when one finds the fremitus over the left apex equal to that over the right. As Lindsay ('04) says: "If the fremitus be equal on the two sides and marked, suspect a lesion of the left apex. If it be equal on the two sides and ill marked, suspect the right side."

Diminished fremitus should suggest emphysema, thickened pleura, occlusion of a bronchus, or fluid, the first and second being by far the most common causes. However, lessened fremitus is not common.

Monneret (Grancher, '90) insists that the variations in the fremitus must not only be taken between the two sides, but relatively on each side alone. The location of the maximum fremitus in the lung depends on the pitch of the voice, it being higher up in proportion as the pitch is higher, so that in women and children it is strongest in the upper part and nearly absent below, while in men with strong voices it is strongest at the base. Thus, in a doubtful case in a man with a low-pitched, resonant voice, where the comparative fremitus between sides is normal, the discovery that the fremitus at the apex is equal to that at the base would greatly strengthen suspicions of apical consolidation.

In advanced cases with multiple lesions palpation is valueless. It should not be forgotten that a narrow band of adhesions can conduct fremitus strongly under certain conditions, so that at times it can be carried to distant parts, as, for instance, in pneumothorax or pleurisy. Palpation for frictions or for ronchi is of no importance, and may be neglected. Pain on palpation is present in a fair number of the early cases over the apex in front or behind. It is commonest behind, between

the spine of the scapula and the spinal column. Ribard (quoted by Cornet, '07, p. 657) ascribes this to enlarged bronchial glands. Head's painful points, while they may at times be discovered, have given the writer no aid in the study of his cases, and, according to Fowler and Godlee ('98), to connect them with lesions of special portions of the lungs "is a work of some difficulty."

It is surprising how seldom enlarged cervical glands are found. When present they are commonest on the side of the lesion in the lung.

The necessity of palpating for the apex beat need scarcely be noted. When determined, the point should be marked with a blue skin pencil, so as to be used later in mensuration. Displacement of the apex beat to any marked degree suggests fibrosis, except where it is due to pleuritic effusion or pneumothorax. The heart beat can be felt very distinctly as well as seen over the pulmonary valve in fibroid cases, owing to retraction of the lung, though Cornet ascribes this to infiltration of the anterior border of the upper lobe.

Mensuration.—The full *circumference* of the chest should be at least one half the height of the patient, chests under this proportion suggesting a weak constitution. This circumference should be measured at the level of the fourth rib at the sternum in front and the eighth dorsal spine behind, the chest being at rest, but Loomis ('98) advises the average of extreme inspiration and expiration. Brown ('04 A) found the circumference less than half the height in 45 per cent of 80 male cases and in 75 per cent of 95 female cases, which led him to suggest that the standard was probably formed from the measurement of males.

The *expansion* of the chest, according to Fetzer (Vierordt, '89), is from 1.6 inches to 4.8 inches, which does not differ much from the figures of Draper, who gives it as from 2 to 5 inches, and this is much nearer the truth than the considerably smaller figures given by other authors. With such wide normal limits of variation, it is evident that in early cases its determination is of little value, and the writer has frequently seen such patients with an expansion of 4 inches or over, but the loss of expansion during the advance of the disease and its increase during its improvement is so usual that if taken at successive examinations its determination can throw some light on the progress of the case. While a knowledge of the total circumference of the chest, except as suggesting a weak resisting power, is of little value, a knowledge of the two semicircumferences is of considerable value and should always be sought. Despite the contrary view of Waldenburg ('80), a marked lessening of the right side of the chest in right-handed people, or of the left side in left-handed ones, is good evidence of the existence of a lesion on that side, while a progressive shrinkage of the affected

side very uniformly goes with an advancing process and a reëxpansion with an improving one.

Asymmetry of the chest can be demonstrated by the use of the tape between symmetrical points, but the trained eye is more valuable than the tape in determining asymmetry. The calipers are useful in giving the

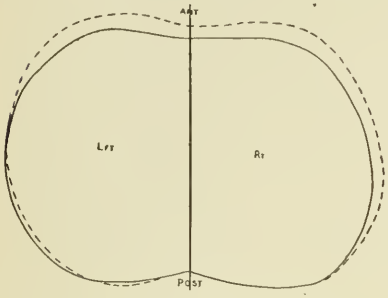


FIG. 44.—CYRTOMETER TRACING OF INCIPIENT CASE (I). Note shrinkage of R. side. Continuous line Dec., broken line April, 1901. Patient right handed. (Disease arrested.) Index 65.

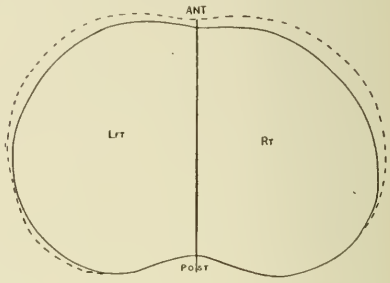


FIG. 45.—CASE IN I. STAGE (R). REEXPANSION AFTER FIVE MONTHS (BROKEN LINE). Disease arrested for some years. Index 63.

depth and breadth of the chest and the depth of corresponding parts of the thorax, especially in its upper portion, which can otherwise only be estimated by inspection; thus the depth of the apex can be measured from

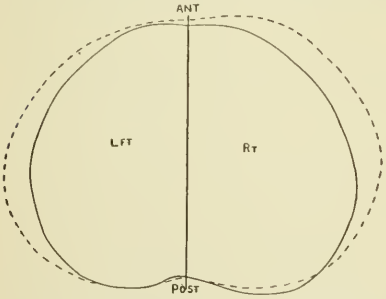


FIG. 46.—ACTIVE RECENT DISEASE ON LEFT SIDE, ARREST, AND FINAL CURE. Index 76.

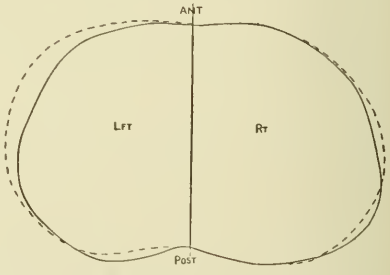


FIG. 47.—MARKED SHRINKAGE IN INCIPIENT LEFT-SIDED CASE (I). Reexpansion very rapid. Two months between two tracings. Index 61.

just below the center of the clavicle to the spine of the scapulæ, or one of the dorsal spines, as advised by Walsh ('43).

The distance of the heart apex from the center of the sternum should always be measured as it gives evidence of alterations in size or of dislocations. Cunningham ('03) gives the normal distance of the apex from the midline as $3\frac{1}{4}$ inches. In his tuberculous patients, the writer has found

it to be rather less than the normal, as an average, varying between 2½ and 3½ inches in men, and from 2 to 3 inches in women.

The lead tape cyrtometer gives the thoracic perimeter at any given level, and makes visible slight alterations of size of one side of the chest, which could not otherwise be recognized, and more especially gives most graphic ocular evidence of changes in shape during the course of the disease. It is of great diagnostic and prognostic value and it is regrettable that it is not more generally used. The writer has used it on all cases for a number of years and through it has been able to demonstrate a slight shrinkage of the affected side in most cases early in the trouble. A slight shrinkage of the left side, except in left-handed people, is, of course, of no value, but such a decrease on the right side is of value as suggesting trouble in the contracted lung. Used in successive examinations, there is no method which will give such beautiful demonstrations of that shrinkage or reëxpansion of the thorax which so uniformly follows advancing trouble or improvement.

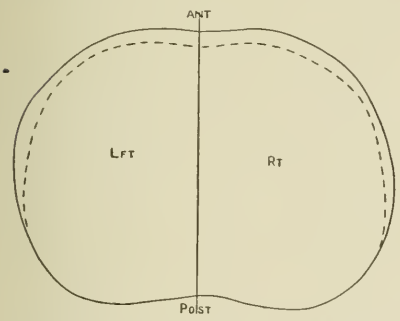


FIG. 48.—FIBROID DISEASE, CONTINUALLY IMPROVING. Showing shrinkage of perimeter. In this case indicating improvement. Tracings ten months apart. Index 69.

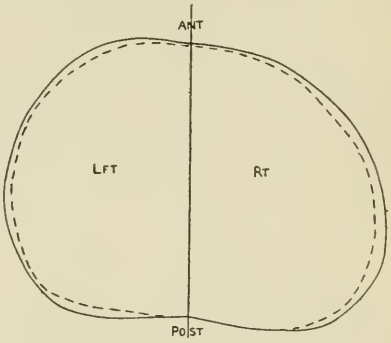


FIG. 49.—STAGE III. PATIENT FAILING. Decrease in perimeter. Index 71.

It is interesting here to note that, as a rule, the increase of perimeter takes place first on the unaffected side, which is doubtless due to a compensatory increase of the good lung, and that the increase of the affected side generally follows this increase on the good side. The increase can be in breadth or in depth or both, though more commonly in breadth than in depth, but since the former is somewhat affected by increase of muscle and fat, it is not, if moderate, as reliable as an increase in depth which, being between bony points, the sternum in front and the spine of the vertebra behind, is positive.

The use of the spirometer is at present largely neglected. While not of as great diagnostic value as Hutchinson, its chief advocate, believed, it is useful, especially in watching the course of a case, although

the patient must be taught to use it properly, and it should not be used in any case where there is a tendency to hemorrhage. Even at a first examination a high reading is not positive evidence of a normal lung, since one at times sees patients with considerable trouble who can give a high reading. An unduly low reading in a patient who has been taught to use the instrument properly, always speaks for a limitation of available lung and suggests tuberculosis, while a high reading, persisting at subsequent examinations and combined with other good findings, increases the assurance with which one can make a good prognosis. Steady increase of reading at each examination is a uniformly good sign, and a steady decrease a bad one, slight fluctuations being of no value.

The value of this instrument is well expressed by Waldenburg ('80). He says: "The spirometer is for general diagnosis of moderate value, but is an invaluable means for founding an individual diagnosis, either as to

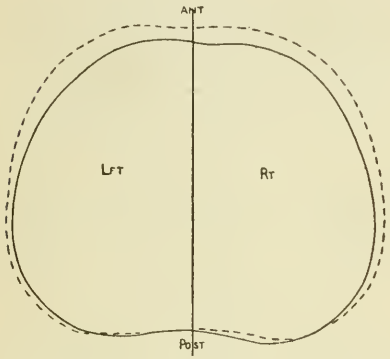


FIG. 50.—ROUND TYPE OF CHEST. Incipient disease on right side (I). Index 80.

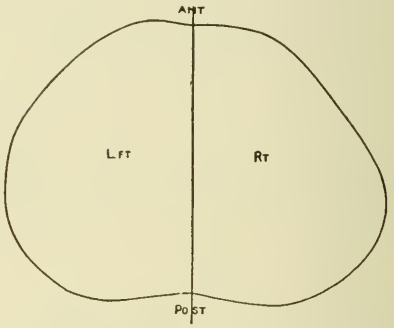


FIG. 51.—"PIGEON CHEST", CASE IN STAGE III. Index 68.

the degree of the involvement or to found a prognosis for observing the course of the disease, and finally for noting the effectiveness or uselessness of every given treatment."

The scales need scarcely be mentioned, as they have been treated of under the subject of emaciation. Diagnostically as well as prognostically they are of great use and should be placed in every examining room.

Corpulence is the relation of weight to height; according to Loomis ('98), the former in pounds, divided by the latter in feet, should be 26 in normal men and 23 in women, or, according to Papillon ('97), the weight in hectogrammes and the height in centimeters should be 3 in women. It ought to be of value in determining the resisting power of patients.

Percussion.—Although the claim of Aufrecht ('05) that percussion "offers positive findings much sooner . . . than auscultation," is perhaps not conceded by the majority of observers, it must be admitted that if properly performed, especially over the apices, it is of great value as a means of early diagnosis. It is to be regretted that its technic is so frequently imperfectly mastered, as in percussion, more than in any other diagnostic procedure, a good result depends on a perfect technic, and careful and delicate percussion will yield results which cannot be hoped for if it is heavy and improperly directed.

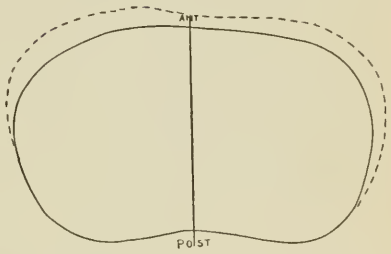


FIG. 52.—FLAT TYPE OF CHEST. Expansion in one year, coincident with marked improvement. Stage III. Patient for seven years with limited working capacity. Index 59.

When it is recalled how slight are the lesions in early tuberculosis, a few small, scattered or conglomerate tubercles in an apex, with some consequent relaxation of the parenchyma, it is evident that only in an apex could one ordinarily expect to determine early changes by percussion at all, and that even then one cannot expect to find early in the disease any marked percussion changes, such as pronounced dullness or flatness. On the contrary, there is usually only a slight "shortness" of note, the duration of the note being less than on the good side and slightly elevated in pitch, or at most an impaired resonance or very slight dullness, often accompanied by a slight tympanitic overnote, due to relaxation of the surrounding lung tissue (Sahli, '02). Instead of this, slight tympany or hyperresonance will at times be found, as first noted by Andral, but the commonest early percussion change is a short, high-pitched note or a slight impairment of resonance, both of which

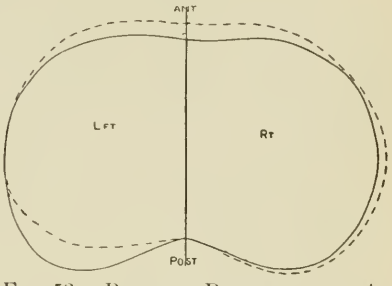


FIG. 53.—BULGING BACKWARD ON ACCOUNT OF SCOLIOSIS. Correction of scoliosis. Index 54.

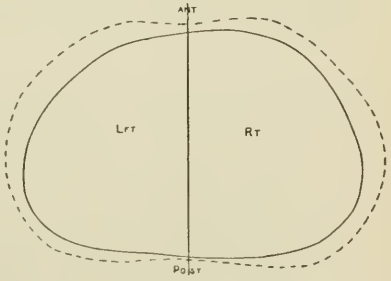


FIG. 54.—MARKED SHRINKAGE OF LEFT SIDE, DUE TO POST-PNEUMONIC EMPHYSEMA. Restoration of normal perimeter in three months by exercises. Index 66.

are more common and more certainly determinable than tympany or hyperresonance. Aufrecht ('05) considers an even earlier sign to be the difference between the percussion note on inspiration and expiration. Da Costa ('75) pointed out that in the normal lung there was a difference in the note on percussion in inspiration from that in expiration, the former being duller, the latter clearer. Aufrecht considers that in the very early lesions in an apex this is reversed, inspiration being clearer and expiration duller.

In view of this respiratory variation, it is wise in doubtful incipient cases that the percussion blow should be delivered over each apex during the same phase of respiration, and in percussing one spot to compare the note during inspiration with that during expiration. The slight retraction of the inner border of the apex, with a lowering of its height, first pointed out by Ziemssen and later more fully studied by Kroenig and Oestreich, is a valuable early sign of a lesion in the apex, and careful percussion will demonstrate a slight degree of such retraction in many early cases. As stated elsewhere (Minor, '06), the slight retraction found at this stage is due not to fibrosis, which is not yet present, but to lessened functional activity, and, if the case is soon cured, it can disappear.

It need hardly be emphasized again that these slight incipient changes demand for their detection the most delicate, light, resilient percussion possible, using one finger only, and using the little finger as a plexímeter. When there are beginning lesions in both apices, it will at times be impossible to determine any change, and other methods will have to be relied on. The slight decrease of resonance, normal at the right apex, which was noted by Flint long ago ('75), renders slight impairment at the left apex of more value than at the right, but slight alterations at the right are too often ascribed to this normal difference. Where hyperresonance is present over an apex, one may be deceived into regarding the other apex as being impaired, and this accounts for the fact, noted both by Turban and Sokolowski, that different competent examiners, examining the same case in the same day, may locate the lesion in different apices.

Again, impaired resonance over the anterior aspect of an apex may be accompanied by hyperresonance on the posterior aspect (Fox, '91) from relaxation of adjacent lung, hence if hyperresonance is noted, the other aspect of the lung tissue should be carefully searched for dullness. At times the remains of an old pleurisy or a healed focus at one apex may produce slight dullness there and obscure the slight signs at the other side where a new process is beginning, but, while such cases may be puzzling, a careful study of the results of the other steps of the examination will suffice to clear up the trouble.

Distinct dullness cannot be regarded as an early sign, but speaks for more pronounced trouble and the coalescence of the scattered tubercles into a solid mass of some extent with little air-containing tissue between. Piorry taught that even superficial lesions to produce discernible dullness must be from 4 to 6 cm. in width and 5 cm. in thickness. Alison ('61) noted that a superficially located spot, one half a square inch in size and one half an inch deep, located in the apex, could produce unquestionable dullness. Oestreich ('98), as a result of autopsies, believes that a consolidated area the size of a cherry can produce dullness with tympanitic overnote; and Flint ('75) reported an interesting case where a mass the size of a hazelnut was discovered.

The note over the apex is not uniform, the outer portion being slightly impaired by the underlying muscles, the inner slightly tympanitic from the neighborhood of the trachea, while the central portion alone gives a clear sound, and in early cases this must be kept in mind and each of these portions of the apex studied separately.

Observers differ as to the commonest seat of the dullness produced by apical lesions. C. J. B. Williams ('87) and Babcock ('07) consider it commonest in the suprascapular fossa, but while, as Fowler points out ('98), lesions commonly tend to spread backward, the structure of the overlying soft parts renders small foci less accessible to percussion here than in front, and dullness is most generally first found in the inner part of the supraclavicular fossa and in the inner third of the infraclavicular region. This agrees with the fluoroscopic findings in early cases, which show that a shadow in the sternoclavicular angle or above the clavicle is very much commoner than a shadow behind. W. Walsh ('71) and Alison ('61) also consider that this region is usually the first site of dullness. With bilateral apical lesions crossed dullness is often found, the apex on one side being dull in front, that on the other side behind.

At times the first lesion will develop directly under the clavicle, and the first spot of dullness will be found by percussion on this bone and not above or below it, a point noted first by Laennec ('19) and also by Stokes ('82), but we must be sure that an unduly arched clavicle or the thickening from an old fracture is not responsible for the dullness. The writer has never felt safe in laying much weight on dullness limited to this bone.

The condition of the soft parts and of the bony thorax can have a marked modifying effect on percussion, especially in the early stages. The strong muscles of a laborer or a thick layer of fat may render percussion useless, and even the difference between a normal, well-nourished, elastic skin and a thin, loose, and relaxed one can cause a difference in note.

Local prominences of individual ribs, or of many ribs, as a result of scoliosis, can simulate dullness, and the unyielding ossified thorax of an old person gives a rather dull note, whereas the elastic chest of a young person gives a sonorous, hyperresonant one. Slight areas of impaired resonance can be mapped out better when approached from the normal resonant lung, and therefore percussion from below upward to a suspected apex is often better than the customary method of percussing from the impaired area downward to the normal.

As the disease advances, these early signs are replaced by easily demonstrable dullness, at times accompanied by a tympanitic overnote (*tympanitischer Beiklang*), indicating at this stage not a cavity, as some have erroneously supposed, but a mass of consolidated lung surrounded by relaxed tissue. Aufrecht ('05) expresses this well. He says: "To conclude from a tympanitic note alone that there is already a destruction of tissue in the apex with cavitation, would be incorrect. We know that in the neighborhood of a pneumonically infiltrated lobe the percussion note is tympanitic, and that the same can occur over an apex with normal tissue in the neighborhood of a considerable area of condensation."

This tympany can be distinguished from the tympany due to a cavity by the absence of change of pitch (Wintrich's *Schall Wechsel*), and one should be very careful before diagnosing a cavity on the strength of dullness accompanied by tympany, though marked tympany surrounded by a wall of dullness is a very reliable cavity sign. Where unduly hard percussion is used a tympanitic note can frequently be obtained over the apex by transmission from underlying bronchi, but as very hard percussion should never be used over the apex, such an error is easily avoided.

When condensation has advanced sufficiently to produce marked dullness, there will frequently be found increased resistance to the finger on percussion, especially in the suprascapular regions. The dislocation of the apex outline, which is present in a slight degree in the early stage, now becomes more marked. The writer has found that either the inner or the outer borders can be altered from their normal position, the outer coming inward, the inner moving outward, though Oestreich —quoted by Aufrecht ('05)—denies that the outer border moves. However, after having percussed out the apical borders very carefully in all patients for a number of years, the writer is positive of the correctness of his statement, which agrees also with the views of Kroenig. The inner border is usually affected earlier, but dislocation of the outer is often plainly marked. (For fuller details of the exact outlines and the methods, see Diagnosis.) While Goldscheider's statement ('07) that the outlines as laid out by Kroenig do not correspond to the exact ana-

tomic apex is correct, Kroenig's lines being only a projection of the underlying resonant area on the skin of the shoulder, this does not in any way affect their diagnostic value, which, since changes in this projection occur very early and very regularly in tuberculosis, is considerable.

Retraction of the base, which is not found in the early stage, is quite common in the second stage, combined with limitation of motion, as can easily be demonstrated if the outlines of the base at rest and on extreme inspiration are marked out by the skin pencil in all cases, and the information as to the mobility of the base yielded by this method and by the fluoroscope is so satisfactory that the writer has not made use of *Litten's diaphragmatic phenomenon* for this purpose.

When dullness becomes pronounced the impaired resonance generally reaches below the clavicle, and the advancing border of dullness will be found very often to run obliquely downward from the outer end or middle of the clavicle to the sternum at the second or third rib, while posteriorly a similar obliquity will often be found, though not as commonly as in front, the dullness running from the middle of the spine of the scapula downward and inward to the vertebræ. The frequency of this oblique position of the dullness can be verified with the fluoroscope.

In examining the upper portion of the lungs by percussion, one should be careful always to percuss the axilla up to its apex, as frequently there will be found a spot of trouble here and not elsewhere.

The area of lung below dullness is usually hyperresonant, probably from relaxation, or, as Skoda ('64) suggests, from hyperfunction, but it must be remembered that the anterolateral aspect of the lung is normally hyperresonant.

Where there is extensive involvement of one lung, the other lung is apt to be hyperresonant through increase of function. Absolute dense dullness over the upper third of the lung is rare, owing to the presence of the large bronchi, and dullness here often has a tympanitic overnote, as already stated. In the second stage, dullness will practically never be found at the base, except in the rare cases where the process begins in this region or where there is a basal dry pleurisy with thickening. Flatness, except over fluid, is not found.

Basal dry pleurisy should always be looked for carefully, and in many cases with beginning apical trouble on one side slight dullness can be found at the anterior base of the other lung, or the posterior base of the affected lung, owing to it.

A very usual location for outlying areas of dullness on the anterior aspect of the chest is the fourth interspace, on the left near the axillary fold, where percussion and the fluoroscope will often show small foci of trouble, separated from the main focus above or lying to the outer

side and slightly above the heart. In view, however, of the thickness of the pectoralis major in this region and the greater arching of the ribs at this point, one must be very careful that this does not deceive.

Posteriorly outlying areas of dullness are apt to appear just above or at the angle of the scapula, especially on the left side, while the main process is still confined to the other apex. Another important area of dullness is between the spines of the scapula and the vertebral column, dullness here being a good evidence of tracheobronchial adenopathy. However, this can be simulated by an unusual muscular development. Anteriorly such enlarged glands can produce areas of dullness, usually more or less semicircular in outline, on one or both sides of the sternum, at the level of the second and third ribs, or over the manubrium.

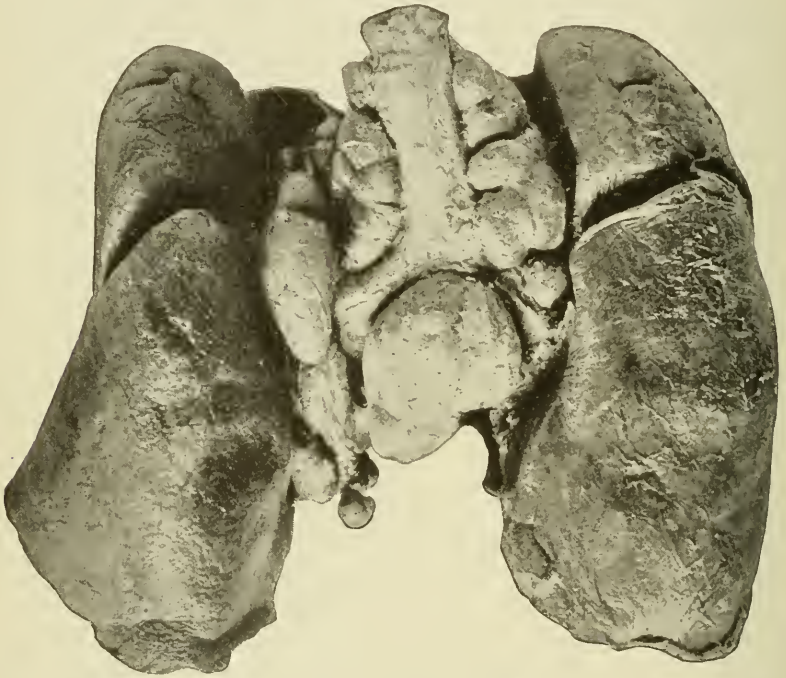


FIG. 55.—TUBERCULOSIS OF TRACHEOBRONCHIAL LYMPH GLANDS IN CHILD FOUR MONTHS OLD. Principal symptom: severe, dry cough, almost constant. Treatment without effect. Pathologically: small tuberculous deposition in both lungs, with area of caseous pneumonia in right middle lobe. In other organs scattered miliary tubercles. (From Holt, "Diseases of Infancy and Childhood.")

Enlarged bronchial glands are, however, more often missed by the physician than found, as can be shown by the fluoroscope, which has demonstrated them in many cases where they were entirely undiscoverable by percussion. Ordinarily they lie too deep to be found, until they

have reached a very considerable size (Fig. 55). When perceivable, they cause dullness in front much oftener than behind, and Barety ('74) ascribes it to their position nearer the front than the back. Anteriorly they should be percussed for by moving the finger slowly inward along the second and third interspaces. If they are much enlarged the dullness will also be found over the manubrium.

When the process reaches the *third stage* the percussion findings are usually more varied, less definite and less satisfactory than in the earlier stages. The upper portion of the lung is usually very dull but not flat, flatness, if present at all, being generally found in the middle or the lower half of the lung behind. The lower portion of the lung in front, especially in the axillary line, generally shows some resonance even in very advanced cases, and this area on the fluorescent screen generally retains some degree of translucence, even in very advanced cases, unless there is fluid or a very thick pleura.

As is natural, in view of the commonness of cavitation in that region, marked tympany, or even cracked-pot resonance, when found, is usually in the upper third or half of the lung, though if the cavities are extensive tympany may extend over almost the whole anterior surface of the lung. Posteriorly, tympany is less common than in front, and cracked-pot resonance very rare; and in the writer's experience signs of cavitation of any sort are rarely found behind below the spine of the scapula, and while autopsies reveal in old cases cavities in the lower portions of the lungs, these would rarely have time to enlarge sufficiently to be easily determinable. In the apex, on the contrary, they can scarcely be overlooked when they reach any considerable size. The retraction of the apex in the third stage is extreme, the inner and outer borders meeting at an angle whose apex lies below the free border of the trapezius, or the dullness may be so marked that they cannot be mapped out at all. The base is also often greatly retracted, especially if there is much fibrosis, and the liver can be drawn upward and backward into the thorax, tympany occupying the normal location of this organ, so that by percussing downward over the fifth, sixth, and seventh ribs there is a transition from normal or moderately impaired resonance to marked abdominal tympany. Such tympany in the site of liver dullness should, therefore, always suggest fibrosis, with liver dislocation. In this stage also the other lung is always involved to a greater or lesser degree.

While some degree of excavation occurs before this stage is reached, and while its determination at an earlier period is more important than at this time, it is in this stage that one can best study the typical signs of cavity. These vary greatly according to the condition of fullness or emptiness, presence or absence of connection with the air, the condition

of the walls—such as smoothness, elasticity, and regularity—the condition of the surrounding lung tissue as to condensation or aëration, and especially according to the size of the cavity. Cavities of less than the size of a walnut cannot be diagnosed, and even such must be superficial if they are to be found, location, as Landis ('06) found, being more important than size in their discovery. No one has followed to the autopsy table cases of tuberculosis without being convinced that cavitation, in some degree, exists very much earlier than is usually supposed or than physical signs can determine, and that many cavities entirely escape notice. The percussion note over a cavity, if the latter is superficial enough and not too small (4 cm.), may be tympanitic, amphoric, or cracked-pot; but if the walls of the cavity are thick, or overlaid with condensed lung or much thickened pleura, there may be only more or less dullness, with or without a tympanitic overnote, and if the cavity is deep enough, there may even be normal resonance over it.

A tympanitic note, while the commonest percussion finding over a cavity, is in itself by no means diagnostic; but a clear amphoric note, if pneumothorax can be excluded, is a positive sign of cavity. A cavity which can give tympany when empty can give dullness when full of secretion, and such a variation between dullness and tympany is an excellent diagnostic sign. Some assistance in recognizing a cavity can be obtained from the variation of pitch on percussion produced by changes of condition or position, this being the *Schall Wechsel* of the Germans.

Various *tone changes* have been distinguished. The simplest is the change in percussion note according to the fullness or emptiness of the cavity, and has been referred to above. The next is Friedrich's tone change, in which the note becomes higher on full inspiration and lower on full expiration. The only important changes, however, are those which bear the names of Wintrich and Gerhardt. The former is obtained by opening or closing the mouth, the note being higher with the mouth open and lower with it closed. When this change occurs only in the recumbent or the erect position of the body (intermittent Wintrich's tone change), it is good evidence of a cavity, and depends on the fact that change of position occludes or opens the opening of the cavity to the air. The simple Wintrich's change of pitch is of but slight value in the diagnosis of a cavity, but may be of value in distinguishing cavity tympany from tympany due to pulmonary relaxation.

Gerhardt's change of pitch is the one produced over a cavity containing fluid, and is brought about by an alteration of position of that fluid by a change of position, usually sitting up and lying down. Since most cavities have their longest axis vertical, the note is usually lower pitched on reclining and higher pitched on sitting up; but where the long axis

of the cavity is transverse this may be reversed. De Renzi ('94) insists on the importance of holding the head straight in trying for Gerhardt's tone change, as changes of position of the head alter the dimensions of the pharyngeal cavity. While this last tone change is a valuable sign, Leube ('91) considering it final if the pitch lowers on sitting up, or if we have intermittent Wintrich's tone change, which, after all, is only a modification of Gerhardt's, the necessary conditions are combined too rarely to make it of great practical value.

Cracked-pot resonance is that peculiar sound produced by firm percussion, without rebound of the fingers, over a cavity which communicates freely with the air when its contents are suddenly compressed and expelled by the percussion stroke. For its production the mouth must be open, but it should be noted that false cracked-pot resonance obtainable over the chests of children, or over other very thin, elastic chests, can be obtained while the mouth is closed, and that at times large, superficial, thin-walled cavities give cracked-pot resonance with the mouth closed. The sound can best be imitated by striking the back of the clasped and concave hands on the knee, which drives the air out suddenly from between the fingers. Skoda explained it as due to a sudden compression and expulsion of the air, and while Wintrich has given another explanation, the former is generally accepted as satisfactory. Not only must the cavity communicate freely with the air, but the walls must be thin and elastic so as to be capable of sudden compression.

Grancher and Cornil ('90) have noted that when it cannot be obtained otherwise, cracked-pot resonance can be gotten if percussion is practiced during expiration. Unfortunately, cracked-pot resonance is oftener absent over cavities than present (Landis, '06), and is not confined to excavations, but it may be obtained in the area above consolidations, or more especially effusions, as well as in children or others with thin, weak chest walls; nevertheless, if it occurs sharply defined and surrounded by an area of dullness, it is pathognomonic, especially if, as Leube ('91) notes, it is accompanied by a metallic tone.

In the third stage there are very marked dislocations of the *heart*, due to fibrosis in the right lung, drawing the heart into that side of the chest, while a similar condition in the left lung can pull the apex upward and outward into the left axilla.

Collections of *fluid* in the chest in pulmonary tuberculosis are not as frequent as one would expect, and owing to the very varied findings in the third stage are often overlooked until at autopsy.

Emphysema is found associated with tuberculosis of the lungs quite frequently, despite the supposed antagonism of the diseases (Grancher, '90). The writer's cases which have presented marked signs of a precedent emphysema have usually done very well. It may be either a pre-

existing condition, in which case there is a typical barrel-shaped thorax, with hyperresonant or boxlike note, with decrease of the area of cardiac dullness and increase of extension of the lower borders of the lungs and loss of motion of the bases, or it may be the result of fibroid shrinkage, with consequent narrowing of bronchi and resistance to expiration, this usually being found in old third-stage cases, and scattered here and there in the lung, so that its diagnosis is very difficult; or it may surround healed apical lesions, partly or even entirely masking the dullness they produce, or replacing it by a nearly or quite normal percussion note.

The percussion in cases which are improving shows a gradual lessening of extent in the areas of impaired or modified resonance, with lessening or, in very incipient cases, disappearance of dullness or impairment and reëxpansion of dislocated apical outlines, but pronounced areas of dullness never return to a normal percussion note, and some dullness and dislocation can be found long after all symptoms have entirely ceased. The limitation of motion of the base can greatly lessen, but does not often disappear entirely. Over healing cavities tympany may gradually lessen, and finally disappear if the cavities are small enough and shrinkage is very complete.

Auscultatory percussion the writer has not found of value, and he has secured from the more usual methods all the information it can offer. In a careful review of the various modifications of auscultatory percussion by Kantorowicz ('06), he comes to similar conclusions, and it can safely be stated that in the examination of the lungs in pulmonary tuberculosis it can be neglected.

Auscultation is the most delicate and acute means of recognizing the presence of tubercle in the lung, but it is to be regretted that as a consequence, and because its technic is more easily mastered than that of percussion, the other steps of a physical examination are too often hurried through in a perfunctory way, while all attention is placed on auscultation. This very common error deprives the physician of many invaluable aids and hints given by the earlier steps of a regular examination. A correct diagnosis may, it is true, often be arrived at by auscultation alone, but a complete one can only be reached by a careful synthesis of all the facts yielded by each step in the examination, and a neglect of any one of them can only lessen the accuracy of the result, and while such an incomplete examination may enable one to make a correct diagnosis of a fairly advanced case, it is unreliable in those early cases where certainty is most needed. In the majority of cases each new step of the examination will develop some slight or more marked deviation from the normal standard which is often most suggestive, and a summation of all these slight alterations will generally enable one, before auscultation has been reached, to get a fair idea of the seat and nature

of the trouble, which this last and most delicate step will confirm and increase.

Cases in which every step except auscultation yields absolutely negative results will be found, but only very rarely, and among the most incipient cases. Remembering the pathology of early tubercle of the lung, the few scattered foci of peribronchial infiltration in the apex involving the vestibule of the alveolus and surrounded by much normal lung tissue, it will be evident that marked changes in the respiratory murmur in incipient cases will not be found. At this time the apex, supra- and infraclavicular fossæ, superspinous fossæ, and interscapular regions will alone give any auscultatory changes.

The alterations physically determinable in the breath sounds in early tuberculosis consist of slight modifications of the normal pitch, intensity, duration, and rhythm of the inspiratory, and a little later of the expiratory murmur over the apices, râles in the very incipiency of tuberculosis being generally absent. To recognize these early changes it is essential first to study each phase of respiration, the inspiratory and expiratory, separately, concentrating attention on the one to the exclusion of the other, comparing that of one side with that of the other, and then comparing inspiration with expiration on the same side. This I would call *single-phase auscultation*; it was developed by Grancher, one of the greatest of auscultators, and a thorough experience with it has convinced the writer of its importance and of its great superiority over other methods in the recognition of early changes in tuberculosis.

Such single-phase auscultation will demonstrate that the earliest changes are inspiratory, a fact which until recently was totally overlooked by the best authorities, as a reference to the works of Skoda, Walsh, Flint, Barth et Roger, Ruehle, Vierordt, Leube, and others will demonstrate. Those expiratory changes which were long regarded as the earliest signs (Ruehle, '87) follow with the increase of involvement, and as consolidation appears merge into bronchovesicular and bronchial breathing. However, thanks to the work of Grancher, the more recent authors now recognize the priority of inspiratory changes (Turban, Sokolowski, Sahli, Fraenkel, de Renzi, Babcock, etc.). It should be noted here that *there is no auscultatory phenomenon which of itself is pathognomonic of pulmonary tuberculosis*, and the alterations found speak for certain changes in the pulmonary tissue, which may or may not be due to tuberculosis, and *only by their locality, persistence, and association with other symptoms do they acquire diagnostic value*, and that, as W. Walsh ('71) says: "The value of these states of respiration is directly as the limitation of the area in which they are discernible."

Auscultation of the First Stage.—The earliest change is the "rough" vesicular respiration, or, since it is more descriptive, *granu-*

lar respiration, the term used by Woillez. This is the *respiration rude et grave* of Grancher and other French authors and the *rauhes Athmen* of Dettweiler and Turban. Until quite recently it has been confounded with harsh, sharp, or puerile respiration, with which it has nothing to do (Sahli, '02). It is related to interrupted respiration and probably due to slight narrowing or uneven surface of the bronchioles (by tubercles here located), into which the alveoli open and where the normal vesicular murmur is formed in health (Grancher, '90), or, according to Turban ('99), to a rapidly interrupted entry of air into the alveoli surrounding the tuberculous deposits. Thus it is always an evidence of parenchymatous trouble. The respiratory murmur is rough and low-pitched, and it is made up of a succession of very short sounds, as though small, soft granules of fine, wet sago were being rolled over each other.

When the sounds become larger and separated from each other by distinguishable intervals, the ear perceives them as interrupted respiration or as numerous fine moist râles.

As there is always difficulty in conveying by words a correct impression of a given sound, and as a good understanding of it is essential to its recognition, and as it is not described in many of the current textbooks, or is confounded with other types of breathing, it may be well to quote a few descriptions of it by other authors.

Grancher ('90, p. 98), who, while not the father of the term, is the one who has done most to develop the importance of this type of breathing, says: "The ear gets the impression of a column of air which glides (*glisse*) with rubbing over an irregular and narrowed (*rétrécie*) surface." Turban ('99), who was one of the first Germans to recognize it, describes it as "a series of short, quickly recurring sounds," and adds, "it depends on their rapidity and strength whether the ear can differentiate them into râles or not," and further notes that they recall to him the rapid vibrations of the hammer of an induction coil. Sahli ('02) speaks of it as "an impure, slightly uneven (*holperiges*) vesicular sound, which now and then gives the impression as if adventitious sounds were mixed with the vesicular sounds," and adds, "if these adventitious sounds can be plainly distinguished from the respiratory murmur we have râles," and ascribes it either to uneven respiratory excursions, to a plugged bronchus, or to the presence of secretion in the bronchioles. Cassaet ('06) says: "The air seems to be constantly passing over slightly elevated obstacles by which it is constantly broken, and this sensation of obstructed progress gives the idea of a rough unpolished surface." De Renzi ('94) describes it as "an abnormal respiration consisting of successive small irregular impulses, and corresponding to the tactile impression one gets when one rubs the beads of a rosary together with the fingers (*wenn man die Glieder eines Rosenkranzes mit den Fingern aneinander reibt*)." Mannheimer ('06) says:

"Instead of being heard as a continuous breezy sound it will be perceived to consist of a series of short puffs following each other in rapid succession."

This type of respiration is most common in the supraspinous fossa, in the clavicular-sternal angle, and in the supraclavicular fossa, in the order named, but it can often be found farther down in the lung on the advancing border of the disease, and its appearance in isolated spots often gives early warning of the development of a new focus.

Grancher considers it most common in the left infraclavicular space, but in the writer's cases it has been commoner on the right. While, like all other auscultatory signs, it is not in itself absolutely pathognomonic of tubercle, it is, when limited to the apex, fixed and not transitory, slowly increasing in intensity until expiration is involved as well as inspiration, and in conjunction with other symptoms a sure sign of beginning tuberculous involvement. Grancher believes that where it is found at the apex, one will often also find it at the base of the same lung, an observation the writer has not been able to verify.

Next in earliness of appearance, but not in diagnostic value, is *feeble breathing*, a lessening of the intensity of the sounds both on inspiration and expiration. It may be either vesicular or slightly rough, and inspiration is feebler than expiration (Herard, Cornil, and Hanot, '88). It is due to obstruction to the flow of air by tubercles or mucus. The writer has found it, in the small areas in which alone it is of value, commonest in the left lung above the clavicle. It can, however, be produced by so many conditions (by limited functional activity, as in adhesive pleurisy, pain, emphysema, obstruction or narrowing of bronchi; or by imperfect conduction of sound, as from thick pleura, fat, or muscle) that it needs to be limited strictly to the apex and persistent after cough, but if these conditions are satisfied it is suggestive of tuberculization. At the base behind it suggests a thickened pleura.

Interrupted breathing (wavy, jerking, cog-wheel breathing, *respiration saccadée* of the French, *saccardirtes Athmen* of the Germans) is a form of respiration in which, instead of the smooth, even sound of the normal respiratory murmur, the inspiratory, and much more rarely the expiratory sound, is divided by short pauses into successive periods, which give the impression as though the column of air were alternately arrested and freed, and, according to Sahli ('02), it is due to a valve-like action of swollen mucous membrane or secretion in the smaller tubes; or, according to others, to the uneven contraction of the lung from the presence of tubercles; or, as Ruehle ('87) thinks, to the rubbing of subpleural tubercles.

While it has been considered by many, notably Peter, as a very early

sign, the writer does not believe that an early diagnosis will often depend on the discovery of this type of respiration, and he has not found it as commonly over the apex as in the clavicular-sternal angle and at the right base behind, or on the advancing border of evident lesions. It is very frequent behind, between the angle of the scapula and the base. It is best auscultated during quiet breathing, as deep breathing has sufficient force to overcome the obstruction it produces and thus remove it (Vierordt, '89). Interruptions in the respiratory rhythm may be produced and real interrupted breathing simulated by several other conditions.

The most deceptive of these is irregular muscle contractions in nervous, timid, or chilly subjects, in whom it is common. In such cases it will be heard very extensively, especially in front. Adhesive pleurisy or pain, by causing irregular expansion of the lung, may also cause it, but the interrupted breathing so caused can easily be distinguished from the genuine. The heart action may also simulate it in inspiration, but will not deceive the careful auscultator.

Grancher ('90) thinks real interrupted breathing can be distinguished from all these forms by the fact that in them the vesicular murmur is normal, while in tuberculosis it is generally rough or weak, but See ('84) considers that it can be pure in tuberculosis, a fact which the writer has noted. Like feeble breathing, its strict localization to a small area is essential; heard over large areas it is certainly false.

Harsh respiration (*verschärft vesiculär*), as already noted, is very often confounded with rough respiration, so that it is well to define it. According to W. Walsh ('71), "both sounds have lost their natural softness, a peculiar dryness accompanies them, the breezy character of health is exchanged for one sharper and more blowing, which is generally more marked in expiration than in inspiration. The intensity of the respiratory sound appears augmented from the superadded character and its duration is increased. Both these latter properties may be, and commonly are, unaffected in the inspiratory sound. . . . In harsh respiration the expiratory sound commonly alone suffers change of quality."

Until recent years harsh respiration with prolonged expiration was considered the commonest early sign of tuberculosis of the apex, as a reference to any standard text-book of fifteen years back will show (Ruehle, '87), a view first advanced in 1833 by Jackson, of Boston (Flint, '56); but such have been the advances in knowledge of the early pathology and diagnosis of tuberculosis that it is now recognized that harsh respiration is not as early as rough, feeble, or interrupted respiration. Grancher ('90), who distinguishes a stage of germination, considers that the appearance of this type of breathing marks the end of this stage, and is accompanied by dullness on percussion, and that

it succeeds rough, low inspiration, and tends to pass gradually into bronchovesicular and bronchial breathing, with harsh inspiration and expiration.

Nevertheless, since few patients are seen in the very incipiency of the trouble, harsh respiration, especially in the expiratory phase, will be the change ordinarily found by the physician at his first examination in the majority of incipient cases, and if it is confined to one apex, and *heard on quiet breathing*, it has great value in diagnosis, and Sokolowski ('06) believes that in this location it is only heard in tuberculosis. However, the writer would note two exceptions to this statement; he has found it quite often at the apex after grippe pneumonias, especially in children, where it may be quite persistent for some weeks, arousing fears as to the possible development of post-grippal tuberculosis, but finally clearing up completely.[1]

The harshness is due to narrowing of the bronchi and condensation of lung tissue, and demands, therefore, a relatively extensive lesion for its production, so that when it is found the case is no longer incipient in the strictest sense. Unlike rough, feeble, or interrupted breathing, it is heard most often at the extreme apex in front, and to a less degree at the extreme apex behind, or in the clavicular-sternal angle.

While commonest at the right apex, the examiner must never forget that such a type of breathing is said to be normally found in a slight degree at this point, especially in anemic young girls, and hence that its value is greatest when found at the left apex, and in men (Walsh, '71). At the same time, since tuberculosis in young girls often begins as a chlorosis, and as the writer has seen not a few such girls who also had incipient right apical trouble, he would advise that not too great weight be laid on the normal appearance of this type of breathing at the right apex if it be found in a slender, pale young girl, with otherwise suspicious symptoms, and be not too quickly passed over as normal to this region, but that such a one be carefully watched and studied before a diagnosis of tuberculosis is rejected. Harsh respiration in tuberculosis, when it once appears, may be most persistent, unlike the inspiratory changes which soon alter, and it often persists for years after the disease is arrested.

Prolonged expiration, or prolonged and feeble expiration, in the absence of harshness, is not of great value. Sokolowski ('06), however, considers that when strictly localized to an apex, and heard on quiet breathing, it is a valuable sign, but Walsh holds the opposite view, as

[1] The writer has also found it along with other rational symptoms in certain cases of syphilis of the apex, and persistent for long periods, and entirely undistinguishable from tuberculosis until the patient was placed on mixed treatment, when it cleared up rapidly and permanently.

does Flint ('75), who says: "Among cases in which a tuberculous deposit exists it is exceedingly rare that diagnosis hinges exclusively on prolonged expiration, and it would certainly be unsafe to base a positive diagnosis on this sign alone." However, as an evidence of compensatory emphysema around a healing focus it is of great value.

Puerile (*exaggerated, supplementary*) *breathing.* While this type of breathing will at times be found over the apex in incipient tuberculosis, it is not a reliable early sign, and is commoner over the healthy lung as a result of compensatory action, or in the area around a focus of trouble. The increased intensity chiefly involves expiration, which is also prolonged, but it does not lose its vesicular quality nor its pitch.

Finally, in speaking of early signs, one should note *the undue transmission of heart sounds to the apex* (Brown, L., '04 A). When the heart sounds are distinctly audible over the right apex it speaks for a condensation of the underlying lung, and is a very valuable sign. When heard at the left apex the sign is not of great value; and in any case, if the heart is beating hard, the value of this sign is greatly lessened. At times other small areas of the lung are found in which the heart sounds are unduly transmitted, especially in the bases behind, and will thus direct attention to spots of congestion, and probably of consolidation, which might otherwise easily be overlooked.

The study of *vocal resonance* in the earliest stage of the disease is of little value, but when there is slight percussion dullness and harsh, prolonged expiration it is usually intensified; but here, again, as in so many other instances, its value is slight unless it is very intense or unless it is found at the left apex, owing to the normal increase of vocal resonance over the right apex. In men with very strong voices it is valueless, and in patients with very weak voices or hoarseness it cannot be tested.

Râles cannot justly be considered as signs of the incipiency of tuberculosis, although formerly they were so considered, and some authors still so regard them. Grancher ('90) considers them a sure sign of softening, but they will not generally be found until the first stage is well advanced, and one should under no circumstances wait until they develop before making a diagnosis. At the same time, while generally a sign of more advanced trouble, certain kinds of râles, if the process is developing actively, can be found very early in the disease, while if its course is very chronic they will not be heard until later. A few fine sibilant râles can frequently be found over the posterior aspect of the apex, or less commonly in front, at the very end of inspiration, but while they speak for a localized bronchitis, they are not of great diagnostic value, unless persistent.

Isolated pleuritic friction sounds (Flint, '75) over an apex, while

not common, are suggestive of a tuberculous apical pleurisy, and acquire great importance when confirmed by other slight changes. At times they may be mistaken, if fine enough, for crepitations.

Of very great importance are the "dry crackles" of Walsh, the *cracquements sec* of the French. As there is much confusion in the use of terms descriptive of adventitious sounds, and as such dry crackles are closely related to crepitant râles, a quotation from the description given by Walsh, a master in the description of physical signs, will be of value. The dry crackle "is composed of a succession of minute, dry, short, sharp cracklings, *few in number*, rarely exceeding three or four in a respiration, coexisting exclusively, or almost exclusively, with inspiration, though in very rare cases most obvious in expiration . . . permanent (that is, not removed by cough) in the great majority of cases, after its character has once been perfectly developed, . . . passing into the moist crackle." The crepitant râle Walsh defines as occurring "in puffs more or less pronounced, but rapidly evolved, composed of a *variable, sometimes immense, number* of sharp crackling sounds, all perfectly similar to each other, conveying the notion of minute-sized, dry bubbles, coexisting exclusively, except in rare cases, with inspiration, and, once so established, remaining persistent until superseded by other phenomena."

Crepitant râles are not strictly dry, being probably generally produced by the separation of the walls of alveoli which are stuck together by secretion (hence, sometimes heard after very deep breath in normal individuals and called "atelectatic râles") or by pleural frictions (Leaming); but they certainly are not really moist in the sound they give to the ear, which is distinctly a dry sound. When heard, true crepitant râles speak for small areas of pneumonic infiltration.

Recurring to Walsh's excellent description, which agrees with that of Flint ('56), it is evident that the "dry crackles" of Walsh, or the *cracquements sec* of Fournet and Grancher, differ from crepitant râles only in that the former are few in number and isolated, the latter very numerous and in salvos. It would tend to clearness in nomenclature if the former were simply spoken of as isolated crepitant râles. If, as Fox notes, tuberculosis is ushered in by hemoptysis, the first râles heard will be moist, but with this exception, although such excellent authorities as L. Brown ('04 A) and Babcock ('07) differ from the writer's opinion, he is satisfied that in the very incipiency moist râles will not be heard, the typical râle being generally a dry crackle, though if a small area of pneumonia exists there may be crepitant râles, an opinion that is supported by many of the best authorities, such as Fox ('91), W. Walsh ('71), Grancher ('90), and Flint ('56).

Limited to one spot, especially in the apex, but at times in other

areas, persistent after cough and not transitory, dry crackles are in themselves alone presumptive evidence of tuberculosis, and when accompanied by breath changes and rational symptoms justify such a diagnosis. In other spots than the apex they are less to be relied on, but are increasingly suspicious in proportion to their persistence. It must be recalled, however, that at first they will not be heard on quiet breathing, but only on deep breathing, or after cough, and thus it is important in all suspicious cases to make a patient cough at the end of a deep breath, or just before one, if they are to be heard. If heard on quiet breathing, Brown considers the case no longer an incipient one.

The dry crackle tends by degrees to become a moist crackle (W. Walsh, '71), the *craquement humide* of Fournet, and with this change it invades expiration as well as inspiration. Here, again, in the interest of simplicity of nomenclature, it seems that the term "moist crackle" should be given up, since a reference to Fournet or Walsh's descriptions will show that it is simply a fine moist râle ("subcrepitant" râle). To quote Walsh: "A series of clicking sounds—a few in number—of moderate size, occurring during both respiratory movements, but with greater regularity and distinctness of character in inspiration, and eventually passing into, or rather superseded by, ronchi of the bubbling class." In the latter part of the first stage a few such fine moist râles will be found, and Fournet believed that the change from a dry to a moist sound did not occur until from twenty days to three months had passed. Lampadarios, quoted by Cornet, and Stanton, of Philadelphia (personal reference), consider that râles not otherwise discoverable may at times be found if the patient is reclining. Again, râles are more apt to be heard early in the morning, and if not found at the usual time of examination, it may be necessary to auscultate the patient on waking and at various times in the day.

H. Anders ('07) quotes Cybulski as to the diagnostic value of oral auscultation for fine crepitations in early cases, the physician auscultating in front of the patient's mouth during quiet breathing, the sounds being heard both on expiration and inspiration. While the writer has verified this in moderately advanced cases, he has not been able to do so in very early ones.

It cannot be too emphatically insisted that râles, to have any diagnostic value in early tuberculosis, must be strictly localized, in the majority of cases to the apex, and permanent; transitory râles having no value at all, though râles may be absent temporarily.

Auscultation of the Second Stage.—As the process spreads and consolidation appears, with beginning softening, the auscultatory findings intensify and multiply, the most typical being changes in expiration. The breath sounds become bronchovesicular and finally bronchial,

with the appearance of what have been very generally called subcrepitant râles, an unfortunate term for fine and medium-sized moist râles. The expiratory murmur becomes increasingly prolonged and harsh, inspiration begins to rise in pitch, and there is bronchovesicular respiration, so named by Flint. This type of breathing is due to the presence of consolidated areas of considerable extent in the midst of normal lung tissue, the tubular or bronchial breathing produced in the diseased bronchi and surrounding infiltrated lung being modified by being mingled with the normal vesicular sounds of the overlying tissue.

Inspiration is less vesicular than in health, being a mixture of normal vesicular breathing with the tubular quality of bronchial breathing. Its pitch is raised and it is not continuous with expiration, being shortened, while the resultant inspiratory pause increases with the increase of the consolidation, and the advance toward pure bronchial or tubular quality. The name bronchovesicular is so appropriate that it is to be regretted that the term indeterminate (*unbestimmt*, Skoda, '64), a most unsatisfactory and undescriptive term, has been used so largely, and the writer believes with Turban ('99) that it should be abandoned. When finer distinctions are to be made the term vesiculobronchial, as suggested by Da Costa, can be applied to the earlier stage in which the vesicular element predominates, bronchovesicular to that in which the bronchial element is most prominent. This type of breathing is of very great diagnostic value and speaks for a considerable tuberculous deposit in the apex. While slight degrees of vesiculobronchial breathing may be found at the right apex in the normal lung, as noted by Flint ('56), the writer has never found distinct bronchovesicular breathing in normal lungs, but if vesiculobronchial breathing is heard at the right apex it must be pronounced to be of significance in diagnosis.

Bronchial breathing, except in acute cases (De Renzi, '94) where consolidation is rapid, never appears suddenly in tuberculosis, but develops out of bronchovesicular breathing, and its presence evidences considerable consolidation near the surface, connected with the air by a bronchus. In this type of breathing all vesicular quality is lost, and the respiration becomes what the French call a *souffle*. It is harsh and loud, inspiration is high-pitched and prolonged, and the intensity of both sounds is increased, especially that of expiration, in which phase it is best heard, but, owing to the less intense consolidation in tuberculosis, the typical bronchial breathing of pneumonia is rarely found.

When the process has gone far enough to produce bronchial breathing in one lung, auscultatory changes are usually found on the other side, together with exaggerated breath sounds, weakened breathing, or the various signs of early tuberculosis, or even bronchovesicular breathing.

In this stage one will at times find absent breath sounds, chiefly behind, but a few strong coughs will often remove the mucus which, by plugging a bronchus, causes it. Sibilant, whistling inspiration, heard loudest on each side of the sternum, at the level of the second rib, or between the scapulæ, and transmitted downward and outward, is at times found in this stage, when enlarged bronchial glands exist, and speaks for pressure on the bronchi and is a valuable diagnostic sign of adenopathy. Usually one will find along the border of the more marked abnormal breath sounds a zone in which the earlier breath changes can be heard; for example, bronchial breathing merging into bronchovesicular breathing, and this into rough, feeble, or interrupted breathing. The normal occurrence of bronchial breathing between the scapulæ over the large bronchi must not be forgotten, as it might lead into error.

The typical râle of this stage is the small or medium-sized moist râle, due to bronchitis and softening, and which has been unfortunately called subcrepitant, a term which causes much confusion. Cabot ('05) advocates making no distinction between the "subcrepitant" and crepitant râles; but since the crepitant râle is essentially a dry râle in sound, and the "subcrepitant" râle is a moist râle, and the distinction of dry and moist râles is useful and justifiable, this is unfortunate, and the majority of recent authors distinguish them sharply. The difficulty of distinguishing between the crepitant râle and the dry crackle has already been referred to.

Fine, moist râles, which, unlike crepitations and dry crackles, are heard both in inspiration and expiration, appear over the apex in the end of the first or early in the second stage. They are at first limited in area and scanty, and later become more diffused and more numerous. Their prognostic significance is very great, and while at times they may be present for long periods in favorable cases and over large areas, it may, as a rule, be said that the number and size of the moist râles bear a fairly direct relation to the course of the trouble, lessening of the râles signifying usually improvement, increasing of the râles signifying increase of trouble.

Often, if the patient is doing well, these râles will disappear for long periods, appearing only at intervals when congestions occur. Generally the râles at the apex are medium-sized or small, and Vierordt ('89) considers large râles in this location, where there are only small bronchi, the most certain sign of cavity. At times one will find a single persistent medium-sized moist râle, which from its peculiar sticky quality has been called a mucous click, and some authors consider it of great diagnostic value. More usually one will find ten, twenty, or more fine or medium-sized râles, not pronouncedly moist and not permanently removed by coughing. As the process advances the râles be-

come larger and occupy inspiration and expiration completely, are more numerous, cover a greater area, and are apt to become resonant (consonant, *klingend*), such resonance speaking, like bronchial breathing, for cavity formation or consolidation. In this stage one will very commonly find at the base, and chiefly at the anterior lateral base, on the side opposite the chief lesion, signs of dry pleurisy, with fine or medium-sized frictions reaching up as high as the fifth rib. And when the frictions from below merge into an area of the lung showing dry or fine moist râles, it is with the greatest difficulty that one can determine positively where the friction sounds end and the râles begin. And when, as in a diffused process, râles and friction sounds coexist, the difficulty is insuperable.

Leaming ('84), a brilliant physical diagnostician, was puzzled by the distinction of fine frictions from crepitant râles, and after a number of autopsies in which he found that what had apparently been typical crepitant râles were really pleural frictions, advanced the theory of the pleural origin of the crepitant râle. Most authors now admit that in this he was in part correct. Certainly a distinction is often impossible. Trousseau, recognizing the difficulty of the distinction, called such doubtful râles "friction râles" (*frottements râles*).

On reading a text-book of physical diagnosis such a differentiation might seem a simple matter. But unless the frictions are loud and unmistakably pleuritic, which is true in only a minority of the cases, none of the rules given will serve, the distinction being one of the most difficult the auscultator has to meet. The pleural friction is said to be increased by the pressure of the stethoscope, unlike the râle, but this maneuver will often not prove of assistance. Cough should remove or modify the râle and intensify the friction, and when one can demonstrate this it is a valuable sign, but is more often absent than present.

Cornet ('07) quotes Prodi to the effect that oral auscultation intensifies resonant râles, while pleuritic frictions are weakened or not heard. The fact that pleural sounds seem to be directly under the ear is more reliable, but loud superficial râles can seem equally close. Pain is as often absent as present over pleuritic frictions.

Grancher ('90) says: "When a sound like a moist crackle or a subcrepitant râle is heard at the end only of inspiration, and continues into expiration, we can reasonably attribute it to the pleura, because the large crepitations of pulmonary or bronchial origin exist from the beginning of inspiration. Further, it is characteristic of almost all light frictions that they only commence in the second part of inspiration, to continue during expiration, so that the ear has a paradoxical sensation of sounds similar to mucus râles, developed a long time after the passage of air in the bronchioles."

On the whole the writer believes that the only two fairly reliable points are clinical rather than physical—the persistence of the sounds, if pleural, in stationary or improving cases, and the fact that they are often found over areas in cases where râles so extensive would almost necessitate severe constitutional symptoms, yet in which health is fair.

A young man, who at the first examination showed diffused over the front of his chest on the left side numerous apparently fine moist râles, had been pronounced to be in an advanced and almost hopeless condition. The total absence of rational symptoms, sufficient to justify such signs, led the writer to suspect that they were largely pleural, but only the subsequent course of the case, which has been one of very good health and working efficiency for years, showed that the assumption was correct. Turban's statement that there is no certain method of distinguishing fine frictions from râles is, therefore, fully justified.

At the bases posteriorly one will frequently find fine or medium-sized frictions, which point to an old pleurisy, and in this same region, even in healthy people, on coughing one can usually get one or two transitory atelectatic or unfolding râles which are of no diagnostic value. Aside from friction sounds, one can at times be misled into suspecting the presence of râles by the sounds produced by the act of swallowing, by the friction of hairs under the stethoscope, by movement of the stethoscope on the dry skin, and more especially by muscle sounds. The act of swallowing can produce sounds very much like medium-sized moist râles over the apex, in front and behind, and since patients will generally after a cough swallow unconsciously, the examiner must be on his guard when, in auscultating the apex, he asks the patient to cough and take a deep breath, for some patients will swallow between the cough and the breath, thus producing most confusing râles. Patients should be warned not to swallow after the cough when performing this maneuver. Their occurrence and nature can be demonstrated very easily by a trial on the patient.

In the case of patients with hairy chests crepitations can be caused by frictions of the stethoscope, but these should not give much trouble, and an application of vaselin (or water) will quickly remove these frictions, and in very hairy patients such an application should be a routine procedure.

In patients with a dry skin, for a similar reason, careless application of the stethoscope should be guarded against, and here also vaselin is useful, but it should be noted that with the use of the binaural stethoscope, which is almost universal in this country, unduly hard application of the stethoscope is much less likely to occur than with the monaural.

Muscle sounds, if the patient is in a proper, restful, easy position during the examination, will not generally prove troublesome, but in some patients in the suprascapular regions they are very confusing, though Walsh thinks them more common in the infra-axillary regions. They are caused by the vibration of the muscle fibers on contraction, and hence are oftenest heard on forced breathing, or in patients in a constrained attitude, or in those who are chilled and shiver. Such sounds continue when the breath is held.

Cabot ('05) would distinguish them by their being less clear cut, beginning and ending less distinctly, and being less crackling or bubbling in character, as well as by their muffled distant character. He says that probably many râles described as "crumpling," "obscure," "muffled," "distant," or "indeterminate" are in reality due to muscular contractions. Sahli claims that they may simulate rough breathing, but this is doubtful.

Turban ('99) dwells especially on the transmission from one lung to another not only of sonorous râles but of moist râles. The writer has often found such a transmission in the back between the shoulder blades, but never in front, from apex to apex, as Turban reports. Such transmission can be distinguished by slowly following the sounds from one side to the other and noticing the persistence of timbre and pitch with change of intensity.

Vierordt ('89) warns against mistaking bronchial râles transmitted from the hilus of the lung to the apex for evidence of apical catarrh. A little care, however, in the examinations can obviate all these sources of error except in unusual cases, and with increasing familiarity with such work such difficulties will largely disappear.

Insuperable difficulties in auscultation can be created by the presence of *asthma*, which, despite the fact that there seems to be some antagonism between the two processes, is frequently met with in tuberculosis. The innumerable sibilant and sonorous râles completely hide any other signs, and one will have to wait for a period of cessation of the asthmatic signs before any opinion can be given. *Aphonia* and *hoarseness* may make auscultation of the voice impossible. *Perforation of the nasal septum* produces a loud, harsh, high-pitched breathing which makes proper auscultation of the breath sounds difficult and useless unless the nose is held, and if a nasal examination is neglected it may prove puzzling.

In this connection it is to be noted that a large percentage of patients will produce, by faulty nasal- or mouth-breathing, abnormally harsh respiratory sounds (see Diagnosis), and that in such cases, which are frequent in America, where nasal obstructions are common, it is essential to use quiet mouth-breathing and teach the patient how to carry

it out properly. Many patients produce an excellent imitation of bronchovesicular breathing in the nose or larynx, and the examiner should be most careful to listen to the breathing of each patient, both during quiet and deep breathing, and if necessary teach him how to breathe correctly before proceeding to auscultation.

At one time great weight was laid on the value of a *subclavian systolic murmur* in the early diagnosis of this disease. It was first discovered by Stokes ('82) and ascribed by him to a falling in of the subclavicular region and consolidation. He noted that hemoptysis or leeching would remove it, but did not lay any weight on it as a diagnostic sign. W. Walsh ('71) quotes Palmer, who found it present in 102 out of 497 healthy workmen, and considers it a pressure murmur and so common in the healthy as to be of no value. Ruehle ('87), who laid considerable weight on it as an early diagnostic sign, believed it was due to a kinking of the artery by pleural adhesions, where it crossed the apex of the lung, and considered a systolic subclavian murmur, near the end of expiration only, in the outer part of the subclavicular fossa, an evidence of pleural adhesions at the apex. While it is found quite often, its value in diagnosis is small, its frequent presence in health rendering it unreliable as a sign of apical adhesions, and this seems to be the consensus of the more recent opinions on the subject.

Accentuation of the second pulmonic sound is very common in moderately advanced or old cases, and if much fibrosis exists a pulmonary systolic murmur may be produced. A roughening of the tricuspid systolic sound is also common. Sokolowski ('06) lays great weight on the value of small areas of persistent, fine, moist râles in the lower portion of the lung without percussion or other auscultatory changes, as speaking for small foci of infection, as yet too small to give other signs, but which will sooner or later manifest themselves. In these areas the breath sounds are generally unaltered, which makes their value doubtful, but it is not safe to suppose that adventitious sounds will necessarily be accompanied by breath changes, as frequently this will not be the case.

Auscultation of the voice, on which formerly, through the influence of Laennec, much stress was laid, has not yielded the results anticipated, and modern physical diagnosticians do not rely on it to any great extent. W. Walsh ('71) has well stated it when he says: "The signs derived from modified vocal resonance are uncertain in character and obscure in theory, and though occasionally not devoid of clinical significance, hold, as a rule, a very low place among physical aids to diagnosis." Formerly great pains were taken to differentiate bronchophony from pectoriloquy, etc., but to-day it may safely be asserted that the

chief thing to which attention need be given is the increase or decrease of vocal resonance (Flint, '56). The results of the determination of an increase of vocal resonance in the writer's experience agree very closely with those of percussion, and are of some value in verifying the latter, but one is often surprised by the lack of correspondence between vocal fremitus and vocal resonance, though they generally roughly correspond. Increased vocal resonance, which is only a lessened degree of bronchophony (Sahli) adds nothing new to the information obtained from bronchial breathing and resonating râles, and like them speaks for consolidation or cavity formation. It is scarcely necessary to recall that the voice at the right apex is normally more resonant than at the left, so that, equally with vocal fremitus, an increase in this region must be very marked to have any meaning.

The whispered voice gives a better impression to the ear than the spoken, since this normal exaggeration of vocal resonance at the right apex is less marked, and Babcock ('07) considers the sound clearer and more sharply defined in whispering than in speaking. The writer has found that patches of increased vocal resonance in the posterior bases, just like areas of undue heart transmission, give useful early warning of the development of foci of trouble, and changes here are more easily determined, since vocal resonance, in women at least, is normally less below than above. In the estimation of vocal resonance, however, one must take into consideration the timbre of the patient's voice and the formation of his thorax. Men and deep-voiced people, or those with firm chests, have more vocal resonance than children and women, or those with weak chests. Once established, increased vocal resonance is very persistent (Flint, '56), so much so that in a bilateral process one will at times find the vocal resonance increased on the apparently well side as the result of an old healed process, while the active trouble is in the other side. Decreased vocal resonance is found at times over pleural effusions, thick pleural membranes, emphysema, or if the bronchus leading to that portion of lung is plugged, but it is not usually of very great value.

Pectoriloquy is chiefly useful as a cavity sign, hence is dwelt on under the auscultatory signs of the third stage, but it should not be forgotten that it may be found over a consolidation if the consolidated patch contains a bronchus, and that whispering pectoriloquy should never be relied on too implicitly in the diagnosis of cavity formation.

Egophony, a tremulous, intermittent, bleating voice, was considered by Laennec pathognomonic of pleuritic effusion, and is usually found in that condition above, or just at, the level of the fluid, but, like pectoriloquy, it may at times be found over consolidations, but it is not common in tuberculosis.

When a patient is aphonic, or hoarse, Sehrwald's *plegaphonia* (Anders, H., '07), or artificial vocal resonance, is of use if it is important to test the vocal resonance. The thyroid cartilage is lightly percussed by the hammer, using a pleximeter, with the patient's mouth closed, and the resultant pulmonary sounds are auscultated.

Aufrecht ('05) speaks of what he calls a "bronchial after-sound" (*bronchialer Nachhauch*) in cases of infiltrated lung and pneumonia. It is a rough bronchial after-sound heard at the end of the spoken word, or after it, which corresponds to the expiratory bronchial breath. He claims to have been the first to note it, but Flint referred to the same thing as a bronchial *souffle,* accompanying the spoken word, and quotes a case in point.

Enlarged bronchial glands are most apt to be found in the second stage, though the fluoroscope will at times reveal them in incipient cases. The most typical auscultatory sign of such enlarged glands is a sibilant inspiration heard on one side, or less often on both sides, of the sternum, at the level of the second or third ribs, and it is transmitted downward and outward. Less commonly it will be heard behind between the scapulæ and the spinal column. This is most suggestive, if not diagnostic. It is due to a compression of one or both main bronchi by the glands. Baréty ('74) considered a blowing bronchial expiration, commonest behind, as very typical. Barthez and Rilliet ('61) noted as diagnostic a large, noisy ronchus, masking the respiratory sound, transmitted to a distance, very persistent, unlike a sibilant râle of bronchitis, and due, they believed, to tracheal compression.

Emphysema, if in scattered foci due to phthisis, is difficult to recognize, but if limited to an apex around a focus of trouble the typical prolonged feeble expiration will often serve to enlighten one. When general, it has antedated the tuberculosis, and gives all the signs on inspection, palpation, and percussion, which make it unmistakable, but in such a case it can render the auscultation of the tuberculous lesions much more difficult.

In all stages of pulmonary tuberculosis, but especially in the second stage, it is needful to remember that there always exists in the lungs much more trouble than the most acute diagnostician can discover, and that what is found are only the more superficial or advanced lesions, while, as innumerable autopsies have shown, there is always an advancing border of trouble which stretches well beyond the extreme limit determinable by physical diagnosis.

While the general tendency of tuberculosis is toward a gradual spread of the disease, a few cases which, while not advancing toward a cure, will remain stationary for long periods, the signs not changing materially, and while of course one would prefer to see a gradual retro-

gression, with clearing up of the involved areas, such cases are often very favorable and speak for the development of fibrosis.

When a case is advancing toward cure, there is noted first a diminution in the number, size, and quality of the râles, abundant râles becoming scanty, large râles becoming small, and moist râles becoming dry. With this there occurs a lessening in the intensity of the breath sounds which retrograde in somewhat the same order in which they have advanced, though where there has been any but the slightest trouble, normal, pure, vesicular breathing never entirely returns, although the impure breathing may be masked greatly by the development of compensatory emphysema. While in the most favorable cases râles disappear entirely, this is not always the case, and the writer has seen patients who have been well for years in whom he could demonstrate small patches of fine râles, generally dry, though they sometimes seemed moist, and these are probably pleural and not parenchymatous.

Auscultation of the Third Stage.—The use of the term *stage of cavitation* for the *third or most advanced stage of tuberculosis,* has often been objected to on the ground that cavities exist at a much earlier period, as shown by the fact, demonstrated by Sokolowski, that elastic tissue can be found in the sputum within a few weeks of the discovery of early signs; but while this is true, and on anatomic and pathologic grounds the term is not correct, clinically and in the study of the physical signs it corresponds very closely with the facts, and this stage is especially characterized by the signs and symptoms of cavitation which generally dominate the clinical picture, though, as Fox notes, signs of extensive solidification and of fibrosis are also prominent. Cabot ('05) considers these latter the most prominent.

Just as the first stage is marked by slight changes in the inspiratory and expiratory murmurs and fine dry râles, the second by bronchovesicular and bronchial breathing and medium and fine moist râles, so this stage is characterized by tubular and cavernous breathing with metallic overtone (Leube, '91) and large, moist râles and gurgles with resonating character. At the same time it should be noted that, on account of the multiplicity of lesions, the signs of the third stage are usually extremely varied, which makes its auscultation often most unsatisfactory and confusing, as can well be understood when one examines the lungs of such a case at the autopsy. Thus it is much more difficult in the third stage to draw correct conclusions as to the exact existing physical conditions in the lungs than in the other stages.

As the process so generally begins in the apical regions and advances downward, the third stage generally shows the signs of all the stages, advanced cavity formation above, consolidation with softening in the middle and disseminated tubercles below, so that, as a general rule, the

signs of the third stage are found above the fourth rib, and cavities will not be discoverable in the base except in very old chronic cases of long duration.

When it is recalled how many conditions must be satisfied before a cavity can be demonstrated—superficial location, considerable size, no cavity less than a walnut being discoverable (Gerhardt, '90), connection with the air, more air than secretion in its contents, etc.—and that there is no single sign which can be considered pathognomonic, it is not remarkable that autopsies show such a large number of cavities which were overlooked during life. Landis ('06), in an excellent study of 76 cavities in 53 cases in the Phipps Institute, of Philadelphia, which had been carefully observed by the staff, found that 58 had been recognized and 18 overlooked, a better percentage of diagnosis than would usually be obtained. Fortunately, the determination of the presence of a cavity, while important, has not the extreme importance once attached to it, for, as Sokolowski says ('06), the presence of excavation, whose recognition is important, can be sooner and more surely determined by the discovery of elastic fibers in the sputum, though of course this gives no information as to its location. Moreover, the diagnosis in this stage never depends on the physical signs, and examination is apt to be of more importance from a prognostic than a diagnostic standpoint.

Bronchial or tubular breathing, as has been noted, appears in the second stage, with the occurrence of appreciable amounts of consolidation, and so in itself cannot be considered a characteristic of the third stage. It is, however, very commonly found, since areas of consolidation are always present, and Loomis ('77) taught that in advanced tuberculosis a cavity could be suspected if there was found intense bronchial breathing, localized, and accompanied by metallic moist râles. The typical respiration of the third stage is cavernous or more rarely amphoric. Most of the German writers following Skoda ('64) admit no distinction between bronchial, cavernous, and amphoric breathing, Leube ('91) considering the latter to be a bronchial breathing with a metallic tone, but Sahli treats of them as distinct subvarieties, and the majority of American, English, and French authors recognize their distinction as independent types as valid, and it seems that either as a subvariety or as an independent type the division should be recognized as justifiable and useful. Such a difference of opinion, however, shows that there is need of great care in distinguishing them.

Cavernous breathing has a low-pitched, blowing inspiration, bronchial breathing a high-pitched one; in cavernous breathing the expiration is even lower pitched, in bronchial breathing higher pitched; cavernous respiration is weak and hollow, bronchial breathing intense and

tubular. When there is a combination of solidification and cavitation there may be a mixture of both, which Flint ('75) distinguishes as bronchocavernous. Cavernous breathing by itself, if not well limited, cannot be relied on to any great extent, and of it, as of so many other of the signs of tuberculosis, it may be said that it is chiefly of value if circumscribed, combined with other symptoms, and surrounded by an area of bronchial breathing, just as the percussion sign of cracked-pot resonance, to be valuable, must be sharply defined and surrounded by an area of dullness. Of course, if to this are added large moist râles or a metallic tinkle or metamorphosing breathing, etc., the certainty is increased, but such happy combinations of convincing signs are the exception rather than the rule, it being much easier to put together a table of such typical signs for a text-book than to find them combined in a patient, and in Landis's cases 29 showed cavernous breathing, 19 amphoric, and 13 bronchial.

Amphoric breathing is so well imitated by blowing across the mouth of an empty bottle that anybody can produce for himself a perfect reproduction of it. It is metallic and blowing, and is almost unmistakable, but for its production there is needed a cavity of at least 4 to 6 cm. diameter (A. Fraenkel, '91), with smooth, stiff walls and a considerable bronchus entering it, hence it will not be a common finding, but, if pneumothorax can be excluded, generally not difficult of diagnosis, it is a positive sign of great value.

Metamorphosing breathing, in which the first part of the inspiration is high-pitched and resonant, and which changes during the larger part of inspiration to bronchial or vesicular breathing, is variously explained as due to partial occlusion of the bronchus leading to the cavity by mucus which the latter part of inspiration is strong enough to remove, or to the increasing dilatation of the cavity and its opening, which changes its note, or to the entry of air into unequally diseased areas (Sahli, '02). This is a fairly sure sign, but is too rare to be of great assistance.

Large moist râles are the typical râle of this stage, and speak either for rapidly advancing softening or cavity. In the apex, where there are no large bronchi, they are a very valuable cavity sign, Vierordt, as already noted, considering them the most typical sign of excavation in an apex. Lower down they can be produced in the large bronchi, and are therefore not as diagnostic, nor are they as common. When they increase in number and size they become gurgles, which are very numerous and very large bubbling sounds, masking everything else, and which, on the whole, are the most certain sign of advanced and extensive excavation, Stokes ('82) hinging the diagnosis of cavity on cavernous breathing and gurgles. Unfortunately, they are usually found

only in hopelessly advanced cases where diagnosis and prognosis have been long since settled.

In the majority of cavities we find fairly numerous moist râles, with various indeterminate crackling, crumpling sounds, and in the surrounding tissue medium and fine moist or dry râles, which increase with the progress of the disease, but which, when the case improves, gradually lessen and disappear, the cavity being said to become "dry" and only presenting breath and voice changes. Naturally, such "drying" of a cavity is a prognostic sign of great value and good omen. By degrees the fibroid shrinking of the surrounding lung begins, and the signs become less evident, until very often no signs remain, which in a new case would lead to a suspicion of a cavity. Such dry cavities may persist for years, rarely remaining truly dry, but producing generally a small but constant amount of mucopurulent sputum, even when all signs of moisture are absent. If the victim of such a cavity leads a healthy country life in a clean, dust-free air, it will generally remain inactive, but a return to the dust of cities, or much railroad traveling, will often reinfect them with pus organisms and cause a return of active ulceration and moisture.

It is such cavities as these also which in old inactive fibroid cases may cause sudden, and at times fatal, hemorrhages in apparently cured cases, or, if it does not go as far as this, they account for the recurrence at intervals of pink sputum, which will often follow overexertion or colds. The writer recalls such a case in which the cavity had been dry and contracted for two years, and the patient had returned to work in good health, when suddenly, probably from a small miliary aneurysm in the wall of the cavity, hemorrhage occurred with a fatal termination.

While, as a usual thing, the cavities, for the reasons stated earlier, are found above the third or fourth rib, one can, at times, through the coalescence of several cavities, see a whole lobe or more rarely a whole lung converted into a large sac, and a beautiful example of the latter condition is to be seen in the pathologic collection of the Phipps Institute at Philadelphia.

Metallic tinkle is a rare sign. It is not caused, as was once thought, by the dropping of secretion from the wall of a cavity into its fluid contents, but by the bursting of bubbles of air at the surface of the fluid in a cavity with whose note they are consonant. It is only found in pneumothorax and large cavities, and when found is a positive sign of one of these conditions. The Germans, who, as noted, do not distinguish cavernous or amphoric breathing, consider a metallic tone to bronchial breathing, moist sounds, or râles one of the best cavity signs (Gerhardt),

this being but another way of recognizing the value of what in France, England, and America is called cavernous breathing.

The *vocal resonance* of the third stage may be varied, but, as a rule, it is strongly exaggerated. Over consolidation one can get either bronchophony, pectoriloquy, or amphoric voice. Laennec considered pectoriloquy pathognomonic of cavity, but it can be heard over a consolidated lung if a large bronchus passes through the consolidation. It demands a large cavity with firm walls, freely communicating with the bronchus, nearly empty, and superficially located. Such conditions, of course, assure its infrequence. Even whispering pectoriloquy, while a more reliable sign, can be found over solid lung, and W. Walsh, who is supposed to be sponsor for this sign of cavity, says ('71): "Vocal resonance should never be seriously appealed to in diagnosis of a cavity. The form of resonance most nearly distinctive of an excavation is whispering pectoriloquy; but cavities may exist without this, while resonance of the sort may exist under physical conditions directly the reverse of excavation." And again: "Where the quality of the resonance is markedly hollow and ringing, and where it exists in the whispering forms, I long believed that it strongly indicated a cavity; but I have found whispered pectoriloquy over even simple acute hepatization, as well as in the retraction period of pleurisy."

Landis ('06), who found it in a majority of cases and believes it a valuable sign, does not consider it pathognomonic and found it over consolidation about a bronchus. It should not be relied on too implicitly.

Whispering pectoriloquy over a cavity differs from that over solidification just as cavernous breathing differs from bronchial—i. e., it is low and blowing instead of high-pitched and tubular. Once more it can be said that localized, and accompanied by other signs, its value is considerable, or to quote Stokes ('82): "Taken alone it is absolutely without value, but when in combination with other signs it strengthens the diagnosis."

Amphoric voice, a cavernous voice with amphoric echo, demands a very large, thin, smooth-walled cavity, and is most typically heard in pneumothorax, and, like amphoric breathing, if pneumothorax can be excluded it is a positive sign.

To recapitulate, the most reliable auscultatory signs of pulmonary excavation are cavernous breathing, large most râles or gurgles, and whispering pectoriloquy, but the filling of the cavity with pus, the occlusion of its outlet, or its location in the middle of healthy lung tissue, may render its diagnosis impossible. While cases which have advanced to the third stage, with demonstrable cavitation, have a poor outlook for recovery, a small number, as autopsies have abundantly proved, may become arrested if the process is not too active and the

resisting powers sufficient, so that the system can form fibroid tissue around the lesions.

In such cases the symptoms of ulceration by degrees lessen, expectoration becomes less and less purulent and more mucoid, râles decrease and finally disappear, symptoms lessen coincidently with an increase of general vitality and strength, and the patient can reach quite a fair state of health and working efficiency. Such cases are, however, the exception, and may at any time, without any imprudence on the part of the patient, relapse; the dormant disease becomes active, or sudden hemorrhages occur.

Thus if one would obtain permanent and satisfactory results, it is essential to discover and diagnose cases of tuberculosis at a time when the lesion is so limited and so little destruction of tissue has occurred that the body may be able to encapsulate the process, which is, of course, impossible when the disease has reached this stage.

Roentgen Rays.—The discovery of the X-ray and its application to internal medicine has placed at the disposal of physicians a method of physical diagnosis which has proved to be of great value, especially in pulmonary diseases. It has now been used long enough to justify conclusions as to its utility and its limitations in this branch of medical work, and though, as was to be expected, excessive claims have been made for it by some enthusiasts, the majority of physicians, including many prominent radiologists, recognize that, however great its value, it is to be looked on rather as an addition to than as a substitute for the standard methods of examination.

After having used the Roentgen ray fluoroscopically in all his examinations for the past seven years, the writer believes that in the majority of cases an expert physical diagnostician will be able to make a diagnosis of incipient tuberculosis sooner than will the radiologist, but in a few cases the latter will discover small foci of trouble in the lung which neither auscultation nor percussion would reveal. There are certain pulmonary conditions, especially enlargements of the tracheobronchial glands and peribronchial infiltrations, which can be diagnosed far earlier and better by this method than by any other.

Despite its limitations, therefore, exploration by Roentgen rays is a most valuable addition to our means of examination, if used in conjunction with the standard methods. Of the two ways of using the Roentgen ray, fluoroscopy, or the production of a shadow picture on a fluorescent screen, and radiography, or the record of the picture on a photographic plate, the latter gives more complete details, and by it expert radiologists can now demonstrate the existence of pulmonary tuberculosis in certain cases at an extremely early stage. L. G. Cole, of New York, has been able to demonstrate small foci in an apex, and more especially along

the branches of the bronchial tree, and to prove their existence afterwards at autopsy, when they were of such a size as to be entirely undiscoverable by the most acute diagnosticians.

While, however, the radiograph can at times recognize lesions undiscoverable by the fluoroscope, the difficulty is that the expert physical diagnostician is rarely an expert radiologist, or vice versa. Moreover, the apparatus for radiography is so complex, the technic so elaborate,

Fig. 56.—Posterior View of the Lungs in an Acute Active Case, Showing Multiple Cavities (*K*) in the Infiltrated Upper Left Lobe. In the right lung is infiltration (*G*) starting from around the roots of the bronchi, a favorite spot, and in this region a calcified bronchial gland can be seen (*I*). The right ventricle of the heart is enlarged.

the time required so great, and the proper development and interpretation of the plates a matter of such special skill, that its use will necessarily remain confined to specialists, to whom the patient will be sent by his physician for study and report.

On the other hand, fluoroscopy, while in certain cases not giving as

early information as radiography, gives immediate information of great value, is much less time-consuming, the apparatus and technic is much

Fig. 57.—Anterior View of an Old Chronic Process with Intense Consolidation in the Upper Left Lung (*H*) and a More Extensive but Less Dense Infiltration in the Right Side (*G*), and with Peribronchial Enlargements Along the Course of the Bronchial Tree on the Right in its Downward Course. Note also the area of infiltration (*G*) advancing in front of the consolidation of the upper left lobe. In the right lung are to be seen two cavities (*K*), possibly bronchiectatic (surrounding lung relatively clear instead of infiltrated, as usual, around a cavity). The bronchial glands on the right are enlarged at the root and along the bronchi, and where they cross the ribs (*L*) the summation of the two shadows make denser spots. The heart is drawn slightly to the right, which would suggest the existence of fibroid contraction in the right side.

less complex and expensive, and the interpretation of the findings very much simpler, so that the physical diagnostician can easily adopt it in the routine examination of his cases without loss of time. Moreover, it

not only gives him assistance in making an early diagnosis, but it will inform him of the topography of the disease and can visualize to him, as can no other procedure, the condition of the lung. The advance and retrogression of the disease thus becomes actually observable. While the radiograph gives such fullness of detail that it is difficult, even for an expert, to distinguish at times between normal and pathologic shadows, the picture given by the fluoroscope shows none of those misleading normal shadows, and thus is much easier to interpret. Correct information as to alterations in motion can only be obtained by it, and, except for the detection of deeply seated small foci of a half inch or less in diameter, fluoroscopy is most satisfactory. Holzknecht says that in chest examinations radioscopy must be the method chiefly used, and F. Kraus, one of the best-known diagnosticians and clinicians, holds similar views.

The writer believes that the use of radiography will be confined to the X-ray specialist, and that the physician, through want of time, will most advantageously use the fluoroscope. It is hoped that fluoroscopy will be more generally adopted by the profession for pulmonary cases.

Before proceeding to a description of the changes found in the lungs by means of flouroscopy, it need hardly be noted that it is essential that the physician be entirely familiar with the normal fluoroscopic picture if he is not to be misled by certain appearances which might at first seem to him pathologic. The normal lungs, from in front, are seen on the fluoroscopic screen as two irregular, triangular areas of mildly glowing translucence, separated by a more or less triangular, vertical, dark shadow, with its broad base below, which is produced by the sternum, mediastinum, spinal column, heart, and aorta (Fig. 60). The sternum makes a vertical, bandlike, dark shadow, extending from the diaphragm upward to between the shadows of the clavicles, and this central shadow is enlarged to the left from the second rib to the diaphragm by the shadow of the aorta, pulmonary artery, auricle, and ventricle (Fig. 64). This enlargement to the left consists of three scallops, the smaller, above, being that of the aortic arch (Fig. 60), the medium that of the pulmonary artery and auricle, the largest, below, that of the ventricle (Fig. 60). On the right side, extending from the fifth rib to the diaphragm, is a narrow, paler, triangular shadow, cast by the right ventricle (Fig. 60).

The translucence of the lung area increases from above downward, being quite faint above the clavicles and quite bright at the bases (Fig. 60), and brightening considerably on deep inspiration, which also increases the clearness of the cardiac and diaphragmatic outlines. Across this bright area run the shadows of the clavicle and the ribs, and in favorable cases we also see through the intervening lung the posterior portion of the ribs, the superposition of the two producing a latticelike shadow effect (Fig. 57). Above the clavicle the apex rises in a dome

(Fig. 59), the apices being normally of equal height and slightly shaded by being covered, on their posterior surfaces, by ribs and thick muscles. The inner border of the lung area is quite sharply marked off from the sternum and heart (Fig. 60). The outer border is rather indistinct and ill-defined, while the lower border is the most distinct of all, standing out sharply in contrast with the blackness of the diaphragm and abdomen. This lower border curves sharply downward at its outer end to form one side of the costodiaphragmatic angle (Fig. 62), and is shortened at its inner extremity by the projection of the heart, the lower border of whose apex makes an angle with it. In a certain number of patients the air in the stomach makes a bright area below the diaphragm, this muscle being seen in profile as a thin dark arch, movable on respiration and separating this area from that of the lung. In thin subjects with heavy bones one can at times see the shadow of the angle and lower portion of the scapula (Fig. 62), showing through the chest from behind and closely simulating an area of shadow in the lower and lateral portions of the lungs. In the same way, in women the breast may produce deceptive shadows (Figs. 60 and 61), especially in the posterior view, but movement of the scapula or breast will easily dispel doubt.

The heart shadow is quite clear-cut and dark, though not so dark as the sternum, but is lighter in its auricular and aortic portions, and its motion can be well seen, especially on deep inspiration. The motion of the bases should be even on both sides, but the difference between extreme inspiration and expiration is slightly greater on the left side than on the right, owing to the presence of the liver on the right side. It must be recalled that for the same reason the arch of the diaphragm is a little higher ($\frac{1}{2}$ to $\frac{3}{4}$ of an inch) on the right side than on the left (Fig. 56), and that this must not be mistaken for that pathologic elevation produced by shrinkage of the overlying lung (Figs. 59 and 60).

In successful fluoroscopic examinations there is seen on each side of the sternum, from the level of the second rib down to the fifth, a faint ribbonlike shadow (Figs. 59–62), radiating downward and slightly outward from the border of the sternum, and formed by the hilus of the lung, bronchi, and blood-vessels, and called the accompanying shadow of the heart. On a radiograph the same shadow is much more pronounced. The lung markings, indistinct branching or marbled shadows all over the lung, seen in good radiographs of the normal lung (Fig. 61, A), are not seen on the fluoroscope at all, thus removing a fruitful cause of doubt. Seen from behind, the lung area is still of about the same shape, but the outer half of the area is rendered indistinct by the shadow of the scapula, especially by its spine, inner border, and angle, in that order of importance. The shadow of the inner border may resemble an accompanying shadow, but motion of the shoulder blade will

quickly remove any doubt. From behind, the heart shadow is large and less distinct, being farther from the screen, and the right ventricle shows up more plainly to the right of the spinal column than it does in front. The accompanying shadows are not seen from behind in the normal lung.

In thin subjects the clavicle is clearly seen through the intervening lung, dividing the apex from the rest of the lung. Naturally, the fluoroscopic picture is clearest in thin people and children, while in very

Fig. 58.—Anterior View of an Extensively Involved Left Lung. A cavity is seen in the upper left lobe (*K*) with infiltration (*G*) between it and the dense consolidation lower down (*H*). This consolidation is located outside and slightly above the heart, a favorite site for it (see text as also under Percussion). On the right is seen glandular enlargement and thickening around the root of the lung (*F*). The right border of the heart at *B*, despite the left-sided trouble, is not yet dislocated to the left.

fat or very large muscular people fluoroscopy and radiography are both relatively valueless, owing to the lack of definition of the image, which no increase of intensity of the light can overcome. In this connection it is to be noted that the lung should not be examined with tubes of very high vacuum and great penetration, as they obliterate faint shadows and render the picture indistinct and unsatisfactory, and that one should work with a tube of the lowest vacuum that will give a clear picture, just as with the microscope, in the study of details, little light is used, details being obscured by too brilliant illumination.

The picture given by the lung in pulmonary tuberculosis may be varied; on the one hand, with definite and serious auscultatory signs one will, in acute miliary cases, usually be surprised to find a strictly normal fluoroscopic picture, the lung being evenly illuminated in every part, although Williams's sign of lessened diaphragmatic action may generally be discoverable. On the other hand, in old chronic fibroid or pleuritic cases, or in cases with much consolidation or caseation, there are large, irregular areas of shadow, varying in density from a pale gray in recent active lesions (Figs. 59–62), to dense shadows in old inactive chronic (Figs. 57 and 58) trouble, pleural thickening (Fig. 63), or effusion (Fig. 64). Between these two one can find anything from faint, slight mottlings, to dense spots of local shadow (Fig. 60, F). The fluoroscope only discovers condensation, and by recalling the pathologic conditions in acute miliary tuberculosis, and in old chronic cases, the reasons for these findings are clear. The fluoroscope gives information, first, as to changes in motion; second, as to changes in density; and third, as to changes in size of the lung; or, more specifically, as to: (1) changes of motion and position of the base; (2) increase or, more rarely, decrease in the density of lung tissue; (3) enlarged bronchial glands; (4) the comparative size of the two lungs; (5) the size and position of the heart; (6) thickening of the pleura; (7) collections of fluid and air; (8) excavations of lung or dilatations of bronchi. In considering these changes it is well to discuss them as found: first, in incipient cases; second, in moderately advanced cases; and third, in advanced cases.

Changes in Incipient Cases.—The changes in incipient cases are not numerous or pronounced, but they possess considerable diagnostic value, although this value is probably not as great as many radiologists think. Williams, of Boston, states that cases where tuberculosis is shown by the rays fluoroscopically before the physical signs are diagnostic are common, those in which the rays and the signs both indicate the disease are more common, and those in which the signs indicate tuberculosis before the rays do are rare. The statement that usually the Roentgen ray surpasses auscultation in making an early diagnosis is widely at variance with the writer's experience. In a majority of cases a proper physical examination will surpass the Roentgen-ray fluoroscopic examination in a diagnosis of incipient disease.

The number of cases examined by the writer up to date is very large. In these he has used the Roentgen ray for fluoroscopic examinations under the best conditions, and in the large majority of cases physical signs antedated fluoroscopic changes. Walsh says, in disagreeing with Williams's opinion, that he has "not yet seen a case which could be proved to be a case of tuberculosis in which the process could not be demonstrated with a careful (physical) examination."

Béclère quotes the work of Kelsch and Boinon, who in 124 chest examinations of cases of tuberculosis found 73 absolutely negative, which would seem to verify these views. Holzknecht says, as a result of autopsies, that the cases of apical tuberculosis diagnosticated by the Roentgen ray are anatomically not cases of incipient tuberculosis, but old shrunken foci, only showing activity in spots. Such cases are clinically, but not anatomically, tuberculosis. On the other hand, in undoubted cases of apical catarrh one may fail to find any changes, except abnormal diaphragmatic action, and at other times extensive focal shadows. This, he believes, is due to the fact that the latter, which appear as incipient cases, are really exacerbations in old healed foci. The remainder

Fig. 59.—Anterior View of the Lungs in a Case of Early Acute Tuberculosis of the Left Lung. Note the diffused light mottling in the upper left side (*G*), showing the acuteness of the trouble. The peribronchial glands on both sides are thickened (*F*). At *I* are seen calcified glands or tubercles, and the diaphragm on the right is unduly retracted, possibly as a result of the peribronchial trouble. Compare the clear right apex with the left, which is clouded.

of the cases which are clinically doubtful but radioscopically positive, are cases with large, centrally located foci and with slight or little catarrh. "*The really anatomically incipient cases*—i. e., conglomerate tubercles and catarrh—*are*," he says, "*radioscopically undeterminable.*"

The incipient changes are, first, limitation of motion of the base;

second, apex or, more rarely, other shadows; and third, shadows of enlarged bronchial glands.

Limitation of motion of the diaphragm on the affected side was first noticed by Williams, of Boston, in 1897, and has since been verified by all observers. The limitation of motion is at times seen on one aspect (anterior or posterior) and absent on the other, and in any case motion is most markedly limited in that face of the lung which it most involved (Walsham). A limitation of motion can often be found when no other abnormality can be seen on the screen, but the writer has never found limitation to exist in a case where careful auscultation could not determine incipient trouble. Williams, however, considers that it may long antedate any auscultatory changes. The limitation has been ascribed to various causes, but it seems sufficiently and best explained by the loss of elasticity in the diseased portion of the lung which lessens its expansibility, and which also accounts for the retraction of the apex border shown by apical percussion.

As the process advances, loss of motion may become very marked, and is present in all well-marked cases, and, if much dry pleurisy is present, may be absolute. Diagnostically, a slight limitation of motion of the base of one lung would raise other dubious symptoms to a very high value, and make a diagnosis which would otherwise be impossible. By itself limitation of motion is suspicious, but does not justify diagnosis.

Shading of the apex region (Figs. 56, G and 60, G), or, more rarely, small spots of shadow in other regions, is the second early sign of pulmonary tuberculosis on the fluoroscope. A shadow in the apex is usually a uniform fogging over the whole area, and generally of only moderate intensity, and it is often combined with a decrease of apex area (Fig. 62). At times part of an apex will be clear, and again, but not often, there is found one small, sharply defined focus, sometimes just behind the clavicle, more usually above it, and very rarely elsewhere in the lung.

Holzknecht warns against mistaking the dark spots at times formed in a dorsal image by the crossing of the first rib and sternal end of the clavicle for an apex focus. In more advanced cases, with cavities in the apex, these cavities, unlike excavations elsewhere, are not bordered by dense shadow on the upper side, the apex in such cases simply appearing unduly bright and clear, with shading below. In certain early cases the writer has found the apex on the involved side smaller than that on the sound side, though it was not shaded, but usually the shrinkage of the apex and flattening of its domelike outline, with lessening of the height above the clavicle, only occurs when trouble elsewhere in the lung has caused a general shrinkage. Walsham considers a failure of the apex to light up on deep expiration an excellent early sign.

In examining the apex for shadows it must be remembered that this

area is normally less bright than the rest of the lung from being shaded by the ribs and thick muscles behind, but this need not give trouble, as the normal apex has a fairly clear outline, while the involved apex has a hazy and indefinite one. The French school of radiologists believes that the right apex is normally less bright than the left, but the writer is in accord with the Germans, who have not recognized such a difference.

The diagnostic value of an apex shadow is great, but it is not a very early appearance. Béclère's statement that the diminution of the

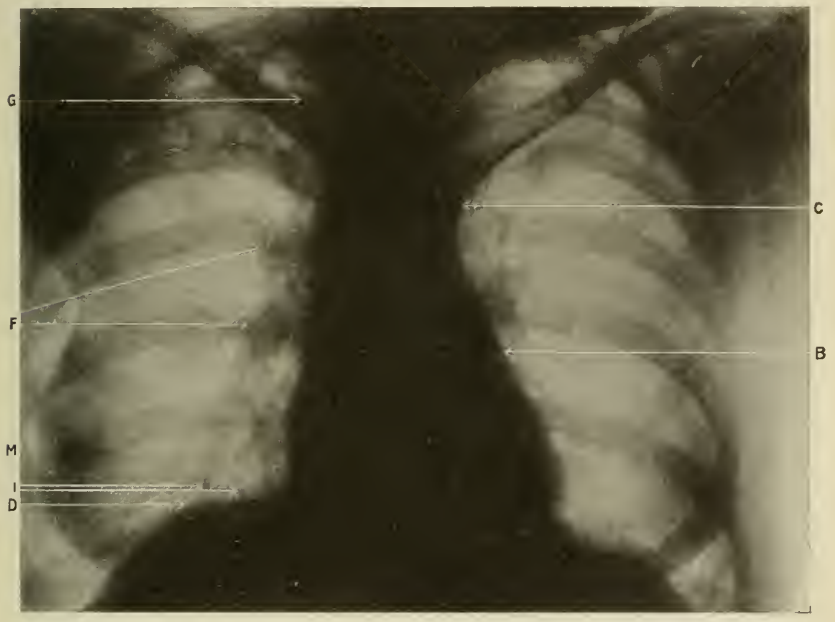


FIG. 60.—ANTERIOR VIEW, SHOWING ENLARGEMENT OF THE PERIBRONCHIAL GLANDS AROUND THE ROOTS SHOWN BY BUNCHED SHADOWS (*F*) ON EACH SIDE OF THE STERNUM, THAT ON THE LEFT BEING JUST OUTSIDE THE AURICULAR SHADOW. At the extremity of the right bronchial tree just above the diaphragm are seen some small calcified glands or tubercles (*I*). The infiltration of the right apex (*G*) extends downward and inward through the sterno-clavicular angle to the bronchial glands, a common finding, and giving rise to the obliquity of the shadows of apical trouble referred to in the text. Compare the clouded right with the clear left apex. Note mammary gland at *M*.

transparence of the apex to the Roentgen rays antedates bronchophony, dullness, and crackles is correct, and the writer has not found that it can antedate rough inspiration, feeble breathing, or slight vesiculo-bronchial breathing, as it must if it is to precede physical signs, and when it is recalled what are the pathologic conditions which produce these slight changes, it seems most improbable that they should cast shadows.

The next incipient change, and one which often antedates any physical signs, is the shadow cast by enlarged bronchial glands (Figs. 59, F; 60, F; 61, F). These can cause two forms of shading. The most interesting and striking, but the least common, is a hemispherical or, at times, a more irregular fusiform mass of shadow on one or both sides of the sternum, at the end of the second interspace, or a little lower, and varying in density from light gray to a very dark gray or almost black, and if the shadow is not very dense, as is the case if the glands are not calcified, it can so merge into the aortic shadow (Fig. 64) as to cause some doubt as to its real nature if it is confined to the left side, as it is usually. The writer has found these shadows quite frequently in cases with incipient apical catarrh, the enlarged glands almost certainly antedating the latter by months or years.

Under treatment such gland shadows can be seen to lessen notably in size, and in some cases shrink sufficiently to disappear from view behind the sternum. Posteriorly, such shadows can also be seen, though not so frequently nor so well, and stand out sharply to the left or right side of the spinal column, about the level of the spine of the scapula, or again may show themselves as a fusiform widening or thickening of the spinal shadow at this point. A large globular enlargement of the tracheobronchial glands will at times be found in syphilis, and as syphilis may cause severe cough and physical signs in the lung, it may be mistaken for tuberculosis.

The more common type of shadow cast by the bronchial glands is seen around the root of the lung and along the main bronchus around the accompanying shadow (Figs. 57, 58, 59, 61, 63). On the left side this accompanying shadow almost, or actually, touches the heart shadow. On the right side it stands out plainly outside the sternum. When the bronchial glands are enlarged, and more especially when they are calcified, this faint, ghostlike ribbon shadow, which narrows and fades away normally about the level of the fifth rib, becomes thicker, darker, can be traced further, and is closely surrounded by, or mingled with, lumpy shadows of greater density (Fig. 57). Schellenberg considers that irregular and pronounced hilus markings are always pathologic, and Koehler believes that only calcified glands or large masses can be recognized by the fluoroscope. While the writer has not been able to follow any of his cases to autopsy, the clinical histories of certain of them lead him to think this statement is too broad, and that glands of very moderate size, say the size of a cherry, can be seen. The shadows are usually seen close to the sternum, but at times farther down along the accompanying shadow, making a small mass of shading just to the left of the heart border (Fig. 61), which may be demonstrated by percussion, and which is probably due to enlarged peribronchial glands.

From behind they are quite frequently seen on the right side as a dark streak between the scapula and the spinal column (Fig. 62), running from the hilus downward and outward, parallel to the inner border of the scapula. As before noted, the shadow of this inner border must not be mistaken for them. On the right side, owing to the proximity of the heart and scapula shadows, they are not easily seen. The detailed study of such glands can be made with certainty with the fluoroscope,

Fig. 61.—Anterior View of the Lungs in an Old Case of Nineteen Years' Standing, Showing Groups of Calcified Tubercles (*I*) and also Thickening (*F*) Around the Right and Left Bronchi. The dark patches (*M*) on each side caused by the mammary glands must not be mistaken for infiltration. At *A* the normal markings are well seen; these, as noted in the text, are not seen with the fluoroscope. Both apices are shaded.

although small calcified nodules, a quarter of an inch or less in diameter, which radiologists show on their plates (Fig. 62, I) will be overlooked.

In incipient cases with congenitally poor chests the fluoroscope draws attention very graphically to the oblique, narrow interspaces and the

acute angle which the ribs make with the sternum. Undue smallness of the heart, so common in this disease, is made especially evident by this measure, and the percentage of cases with small hearts is shown by its use to be very large.

In moderately advanced trouble there are increasing degrees of shadow extending downward from the apex to the second or third ribs, and just as the line of percussion dullness is very apt to run obliquely from without and above, downward and inward, so on the fluoroscope one is often struck with the marked obliquity of the lower border of the shadow (Figs. 56, 60, 63), which in chronic and favorable cases is sharply demarcated from the underlying clear lung. Very frequently, while the apex is still clear, the claviculosternal angle will be filled with a small triangular area of shadow, but, as has been noted, this may be simulated in some degree by a large first rib at its junction with the sternum. Claude, quoted by Cassaet, considers a lack of distinctness of the clavicular shadow in comparison to that in the sound side a good sign at this stage. While in favorable and not very active cases there are quite sharply marked borders and more or less even shadows (Fig. 63), in cases with more activity there will be a general diffuse mottling (Figs. 56, 59), or the advancing border of the trouble will be hazy and ill-defined (Fig. 64). Very frequently the whole area between the clavicle and the fourth or fifth rib is thus mottled over with shadows (Fig. 56) separated by relatively or entirely clear areas, this having a distinctly bad prognostic meaning.

When it is remembered that the more sharply defined dark shadows represent old areas of infiltration and more chronic process, and the lighter indefinite, gray, mottled shadows active and more recent trouble, a fact which soon becomes evident to one working much with the fluoroscope, it will be possible to interpret findings much more satisfactorily.

As a rule, the base of the lung, if free from fluid or pleural thickening, will remain clear even in very advanced cases (Fig. 56), and a uniform shading from apex to base generally means a thickened pleura. The writer has frequently found in the left lung an isolated focus of trouble, which can easily be overlooked by percussion and auscultation, lying under the left axillary fold, halfway between the heart and the outer border of the lung area. A few times he has found in the lung, seen from behind, dark oblique lines running from within downward and outward, and only visible from certain levels; these, Holzknecht says, are due to interlobar pleurisy. That congestions of the lung can give shadows is asserted by Pfahler. That the conditions existing in simple congestion of the lung could cause a shadow seems remarkable, and such a claim would have to be abundantly supported by autopsies before it can win general acceptance. As the writer never rays patients

who have an active disease and fever, he has not been able to determine this point by experiment.

Emphysema, if very general, can be seen as an undue translucence of the lung, but the writer has not been able to recognize the small areas of

Fig. 62.—A Posterior View of an Infiltrated Left Apex (*G*) with Slight Retraction of the Heart (*B*) to the Left. Note the general shrinkage of the left side as compared with the undue size of the right, which is compensatorily enlarged. A calcified tubercle is seen at *I*.

localized emphysema which are its commonest form in tuberculosis, or use it to discover areas of compensatory emphysema around healing foci. It is in this stage that there is ascension of the liver (Fig. 59) through shrinkage of the lung, the diaphragmatic shadow often reaching high enough to touch the angle of the scapula behind or the fifth rib in front.

Pleural thickening usually manifests itself as a diffuse, moderately dense shadow over large areas (Fig. 56), without any mottling, and, as Pfahler says, "shading gradually at its edge into the surrounding clear space." As clinical experience would lead one to expect, such shadows are commonest at the lateral base, cutting down or filling up the costodiaphragmatic angle until the outline of the lower long border runs in a curve from the heart apex upward into the axilla. The writer has found such pleuritic shadings commonest at the base behind, but Holzknecht thinks they are most pronounced in front. Such patients will show little or no shading at the base on one aspect, and a large shadow when turned to the other. In this stage is also found quite frequently

Fig. 63.—Anterior View. In the upper left lung a thickened pleura casts an even smooth shadow not very dense (*R*), so that the lung markings can be seen through it. Both apices are infiltrated and around the bronchi is some thickening extending down to their ends at the diaphragm.

a marked decrease in the size, and more especially in the width, of the lung area (Fig. 62), while it is still almost clear and about normal in shape, except for a little rounding off of the costodiaphragmatic angle.

Small pleuritic effusions the writer has not found often, since, when they are small enough to lie below the level of the arch of the diaphragm they can be hidden by its shadow and totally overlooked, unless the level of the tube is changed or the patient is rotated on his vertical

axis so as to get the costodiaphragmatic angle in profile. When such effusions are larger (see Fig. 64) they usually show themselves as dark shadows with distinct upper borders, having a curved outline, similar to that obtained on percussion. Their change of level on motion is not as rapid as the instantaneous alteration in a pyopneumothorax. Their effect on the position of the heart, if of any size, can plainly be seen.

The fluoroscope will not infrequently disclose an unsuspected pericardial effusion or a dilatation of the right ventricle (Fig. 56). The former produces a pale gray shadow extending more or less outside of the heart shadow, but roughly paralleling its outline. The contrast between the density of the two shadows is so clear as to be diagnostic. Such shadows are much more pronounced on the right side than on the left, and are better seen from behind than in front (Fig 56). Dilatation is seen as an extension of the heart shadow outside its normal area and is commoner than percussion would lead one to believe.

While the writer has seldom found shadows where careful physical examination could not demonstrate signs, he has been frequently surprised in cases with considerable auscultatory signs and with marked symptoms to find a normal fluoroscopic picture. This has been especially the case in those patients, chiefly young girls, who have the physical signs of an acute miliary tuberculosis, but whose disease runs a relatively chronic course, from one to three years, with alternations between periods of fair health and active symptoms, and who uniformly have pronounced tachycardia. Pathologically there must be numerous miliary tubercles which develop much more slowly than usual, and since the fluoroscopic examination demonstrates only condensation, it is natural that such scattered small noncalcified tubercles entirely escape.

All writers on the subject note that in patients with scoliosis there are apt to be areas of even shading in various spots which are not due to a tuberculous deposit, and that in such cases even areas of shadow must not be accepted as evidence of trouble.

In advanced cases, in addition to the conditions already noted, there is very extensive shading and mottling over one or both lungs, and signs of excavation (Figs. 56, 57, 58). The demonstration of cavities by the X-ray, when feasible, is most satisfactory and graphic, but it is sometimes surprising that cavities of considerable size, owing to the condition of the surrounding lung, may be overlooked. Just as a cavity must be sufficiently superficial and large to be discovered by auscultation and percussion, so here, though to a much less degree, they must satisfy certain conditions; they must not be too deeply seated, must not be full of secretion, and while they must not be cut off from the surface by too thick an area of diseased lung, they must be surrounded by condensed lung, a condition practically always existing except in bronchi-

ectatic cavities. Large cavities can entirely escape one in a fluoroscopic examination when smaller ones will be seen distinctly. When the fluoroscope shows a cavity, reliance may be placed on its evidence, but failure to find on the screen a cavity of whose existence there are distinct physical signs need not at all shake our faith in the diagnosis. When seen they show up as a more or less circular or irregularly oval bright spot surrounded by a sharply defined dark wall, which merges gradually on its outer border into the surrounding lung tissue, which is always more or

Fig. 64.—Anterior View of the Lungs in a Case of Pleurisy with Effusion at the Right Base with the Typical Dense Smooth Black Shadow Cast by Fluid (V). The infiltration around the roots of the lungs would suggest tuberculosis, but the fluid was traumatic (fractured rib).

less infiltrated (Figs. 57, K; 58, K). Holzknecht considers they must be the size of a walnut to be discoverable, and I have never discovered any smaller than this, though some claim to have found much smaller ones.

Bronchiectatic cavities, when visible, are seen as lines or chains of radiating cylindrical, or more or less spherical, shadows running downward and outward, but they can only be diagnosed if at different examinations the shadows are sometimes absent and sometimes reappear, their absence being coincident with the expectoration of large amounts

of sputum. Their absence when empty is, of course, explainable by the fact that, being surrounded by normal lung tissue, there is not sufficient contrast to demonstrate them.

In view of the seriousness of the symptoms of pneumothorax one will not usually have the opportunity of examining patients with a simple pneumothorax. It is reported by those who have seen it to be a brilliant reflex over the whole lung, except at its root. More usually the case will have reached the stage of hydro- or pneumothorax before it is seen. No condition demonstrable by the fluoroscope is so striking as this, and only the fluoroscope can show those motions in the fluid which are an essential part of the picture.

The upper portion of the affected side of the thorax shows around the hilus of the lung a small, dark bunch of diseased, retracted lung. Around and beneath this is an area of brilliant light, bounded below, at a varying level according to the amount of fluid, by an absolutely horizontal line of blackness, the line changing level absolutely and immediately with change of position, and showing commotion if the patient is shaken, and slight waves produced by the heart action. The heart, if the pneumothorax is on the left, is displaced into the right side.

Dextrocardia, and other cardiac displacements, are very commonly seen with the fluoroscope. Quite early one will find slight degrees of displacement toward the right in right-sided trouble, or toward the left in left-sided trouble (Fig. 62), and as fibrosis increases this becomes more and more pronounced. The heart is often at first equally bisected by the sternal shadow (Fig. 57), but in extreme cases disappears entirely from the left side, or if the trouble is on the left, it is drawn far over toward the axilla. Finally, until the physician becomes thoroughly familiar with its technic he will find difficulty in seeing the shadows on the screen distinctly enough to gain from it the information it can give. He will, if he persists in its use under proper conditions, be surprised at how much he can see, what assistance he can get from it, and how soon he will learn to interpret the shadow picture correctly.

Blood.—The pallor which is so often seen in phthisis, and which gave to the disease the name of the "Great White Plague," would lead one to expect that the blood changes would be very pronounced and an examination of the blood of great value in a study of pulmonary tuberculosis. While, however, in advanced cases, the alterations in the blood may be marked, in early ones they are slight or, not infrequently, entirely absent, and, as Reinert says, "in no other disease is the disproportion between the appearance of the patient and the condition of the blood so great as in pulmonary tuberculosis," or, to quote Laache, "Phthisis in itself gives rise to no marked anemia in most cases."

Hematology is so new a branch of medicine, and the blood findings

in tuberculosis, until recent years, have been so little studied, that all but the more recent writers on the subject have had little to say about it, so good an authority as Fox saying, as late as the later eighties, "there is nothing definite known about the state of the blood." Even to-day, after Ehrlich's work has placed the study of the blood on a scientific basis, the physician is still unable to draw from it much information in pulmonary tuberculosis, though the recent work of Arneth ('05), if verified, promises to be of great importance in enabling us to form a prognosis from a study of the nuclear structure of the white cells.

Most of our knowledge of the subject up to the present date has come from the work of Grawitz, Limbeck, and Appelbaum, no very promising original work having followed theirs until that of Kjer-Petersen and Arneth.

In the first stage of the disease we will usually find a moderate degree of chlorosis. The chlorosis of this stage differs from a real chlorosis in several respects, and has been called a tuberculous pseudo-chlorosis or chloro-anemia; but as it is often mistaken for real chlorosis, it leads frequently to unfortunate delays in diagnosis and treatment, and the importance of thinking of the possibility of incipient tuberculosis in every case of chlorosis cannot be insisted on too emphatically. French writers (Hérard, Sée, Papillon) would distinguish it, first, by the hue of the facies, which is not that peculiar pale greenish pallor so characteristic of the "green sickness," but a dirty yellowish-gray or bluish-gray; second, by the weakness or absence of the *souffle* in the vessels of the neck (*bruit de diable*) which is so pronounced in chlorosis; third, by the presence of marked fever, tachycardia, and unduly forcible heart beat; and fourth, by emaciation, the real chlorotic usually being plump. Laache and Sörensen note that the mucous membranes in tuberculous chlorosis are not pale as in real chlorosis.

In the second stage, if the patient is undergoing a hygienic cure, he usually has a normal color, but in advanced cases pallor is the rule, often extreme, the skin being ghastly pale, except where two bright spots of hectic flush ominously light up the sunken cheeks.

The morphologic changes in the blood in pulmonary tuberculosis are not very pronounced. The red cells show no very marked decrease in number, except in the last stage. Usually the erythrocytes are moderately reduced in the first stage, normal in the second stage, and moderately or at times greatly reduced in the third stage. Sokolowski gives the count for the first stage as from three to six millions, for the second stage five to six millions, and for the third stage two to four millions. Ullom and Craig ('05), in 39 cases, found an average of 4,510,000 in the first stage, 4,630,000 in the second stage, and 4,297,000 in the third stage. Brown ('07) reports 5,502,410 as the average of 80 first-stage cases,

and 5,680,556 as the average of 75 advanced cases. In this connection, however, it must be remembered that Brown's patients were undergoing a hygienic cure, which tends greatly to raise the blood count. In the first stage, as already noted, the findings were those of a moderate chlorosis, and Cabot notes that, unlike this trouble, in which a majority of the cells are small and pale, in tuberculosis only some of them show such alteration, combined with a slight decrease in total numbers. Poikilocytosis is rare, and nucleated red cells are very rare (Emerson, '06).

In the second stage the slight anemia of the incipient stage is lost, this being generally conceded to be due to a lessening of the total amount of blood by concentration, which produces a relative excess of solids, pigment, and red cells (Sokolowski, '06). This is due, according to Grawitz, to the effect of the toxins of the bacillus which produce a transudation of serum from the blood into the tissues, or, according to Dehio and Appelbaum ('02), to the drain on the serum by the sweats and profuse expectoration. Emerson notes that the hypercythemia of this stage is said to be compensatory for the dyspnea.

In advanced cases there is, with rare exceptions, a fairly pronounced anemia, with a moderate decrease of red cells, produced by the septicemia of the mixed infection. L. Brown found the red cells rarely under 3,000,000, but a few pronounced anemias with very low readings. The number of the red cells can be lessened markedly during and just after hemorrhages, and increased greatly during a hygienic cure. Plethora may be so pronounced as to have a causative relation to bleeding.

The form of the red cells, except for that pallor and decrease in size already referred to, is considered by most observers to remain unchanged, but Maragliano, quoted by De Renzi, describes numerous changes in the morphology of the cells, which he thinks may be found in the incipient stages as well as later. Cabot and Emerson consider that marked changes in shape only occur in severe mixed infections. According to Maragliano, the red cells have not only a reduced diameter, but the central zone is more distinct, with beginning degeneration, and the periphery shows sharp projections and an ellipsoid form. In late cases he considers poikilocytosis and microcytosis, with granulation and destruction of the red cells, characteristic. Malassez notes that, as a rule, the red cells are decreased in number with advance of the trouble, and increased with its improvement.

Coloring Matter.—The hemoglobin is moderately reduced in the first stage, normal in the second, and considerably reduced in the third. Sokolowski gives it as 43 to 95 per cent in the first, 72 to 104 per cent in the second, and 40 per cent in the third stage. Reimert notes that in tuberculous pseudochlorosis the reduction of hemoglobin is much less than in real chlorosis. As a result of the reduction of the hemo-

globin, Grancher notes that the respiratory value of the cell is lessened and the oxygen intake decreased, the absorption of oxygen falling from 28 to 30 c.c. to the hundred to 22 to 24 c.c. This decrease of hemoglobin is not accompanied by any lessening of the iron content, which is proportionately increased. Very characteristic of the first stage is the fact, first noted by Neubert, that the hemoglobin is more markedly decreased than is the number of red cells, but in the second stage it is compensated for, the readings being usually normal or above normal.

The *leucocytes* in tuberculosis until recently have only been studied numerically and in differential counts. In the first and second stages they are normal, while in the third stage, as in all other chronic cachexias, they are increased in number. Ullom and Craig found them to average 10,285 in the first stage, 12,772 in the second, and 14,041 in the third. As long as the infection is purely a tuberculous one, even if it is acute (Sahli), the white cells are unaffected, the leucocytosis of the third stage being the evidence of the development of a mixed infection (Limbeck, '96), and hence a leucocytosis speaks for softening or cavity formation, or for the development of some complication, such as hemorrhage, pneumonia, or fever. While, however, usually developing with excavation, "absence of leucocytosis cannot be considered to exclude the existence of cavities, as has been claimed by Stein and Erbmann ('98), though it would probably exclude one of any considerable size." When present, leucocytosis is usually of the polymorphonuclear variety and eosinophilia, except after the use of tuberculin or at the menses, is absent.

Holmes ('96) reported that he was able to estimate the resistance of the patient by a differential count of the leucocytes, but his work has not been confirmed by other observers. Ullom and Craig ('05) consider that probably an increase of leucocytes is an unfavorable sign in advanced tuberculosis, and venture the suggestion that lymphocytes have a direct relation to the resistance of the system to the disease. Within the last year Craig ('07) has made a careful study of the various types of leucocytes found in tuberculous blood, and was unable to draw any definite prognostic conclusions. Therefore, until the work of Kjer-Petersen and Arneth, the only conclusions that could be drawn from the blood examination in tuberculosis were as to the existence or absence of a mixed infection. Kjer-Petersen ('06), quoted by A. C. Klebs, agrees with Stein and Erbmann, who believe that an increase of leucocytes in tuberculosis, if there is not a chronic inflammatory process, speaks for cavity formation in the lung, that the beginning of cavity formation can be determined by a sudden increase of leucocytes after a prolonged normal period, and that cavity formation can be excluded if normal numerical conditions are found. Arneth ('05) followed a different method than any other observer, not studying the numbers of

the different varieties of leucocytes, but devoting his attention to the neutrophile cells and determining the numbers of those with one, two, three, four, or five nuclear fragments. Quoting Klebs ('06), who reviewed his work:

A neutrophile of Class I, with an absolutely round nucleus, he designates as a myelocyte (M.); the other forms in this class, with more or less indented nuclei, which he thinks correspond to the polymorphonuclears of other authors, he calls, in accordance with the degree of indentation: W. (wenig) for slight, T. (tief) for deep indentations. In other classes he notes whether there are nuclei in the shapes of loops S. (Schlinge) or round nuclear particles, K. (runder Kernteil). . . . The various combinations of loops and round nuclei in the neutrophiles and the three groups in Class I give a total of twenty subdivisions of his original five classes. This seems at first very complex, but after some experience one learns to classify the cells rapidly, according to their respective subdivisions, provided one has a well-stained specimen.

By arranging the numbers found in tables horizontally, one next to the other, beginning with Class I at the left end, he receives what he calls a "neutrophilic blood picture." He finds this picture altered in pathological conditions, though not parallel with the changes in the total number of leucocytes. He can find a profound alteration of the blood picture with a perfectly normal leucocyte count. The cells with the more complex nucleus (higher classes) Arneth thinks are the riper and more efficient ones, while the others are the youthful and therefore less efficient type (contrary to Holmes). The pathological alterations of the blood picture are characterized by the disappearance or decrease of the cells from one class, and the appearance or increase of cells in another; one can then speak of a shifting of the blood picture to the left or to the right. By a great number of examinations of the blood picture . . . Arneth has been able to demonstrate a constant and direct relation between the course of the disease and the relations of the picture. The latter are, threfore, an index of the defensive and protective efforts of the body against infection. Arneth's normal neutrophilic blood picture in a case where the actual leucocyte count was 5,500:

I	II	III	IV	V
5%	35%	41%	17%	2%

This "illustrates a normal distribution of various neutrophilic cell types. We see that the types of Classes II and III predominate, with a fair percentage of cells in Class IV. In the picture next given,

I	II	III	IV	V
36%	56%	8%	—	—

of a case of acute miliary tuberculosis, the patient dying nine days later, . . . we can observe the typical shifting of the picture to the left; practically all the cells are crowded into the first two classes. Only the more

youthful elements are left to carry on the struggle, and this condition increases with the progress of the case. The total leucocyte count is low, 4,400." The next picture,

I	II	III	IV	V
14%	56.5%	24.5%	4.5%	0.5%

is from a patient with extensive pulmonary lesions and signs pointing to a considerable activity of the process. The number of leucocytes is only slightly increased, while the blood picture is markedly shifted to the left. Prognostically, from every viewpoint, this is a bad case. The total leucocyte count is 7,600.

The next two were obtained from far-advanced cases with extensive pulmonary lesions; in the first the leucocyte count was 8,400, and in the second 27,080:

I	II	III	IV	V
55%	38.5%	5.5%	0.5%	0.5%

I	II	III	IV	V
29.5%	60%	9%	1.5%	—

From his own series of examinations, Klebs states, as regards the normal neutrophilic "blood pictures," that they show similar relations to those obtained by Arneth in healthy individuals and that a distinct uniformity of results is quite striking, as well as the ratios of distribution of the five different types of cells. In this regard he confirms Arneth's findings.

The technic of the method is quite simple; particular attention is necessary to insure thin blood smears. Undue pressure in spreading the blood on the glass can lead directly or indirectly to a distortion of the cells, and so change the picture. The stain used by Arneth is the triacid solution of Ehrlich, not a good nuclear stain. . . . For this reason, Wright's stain has been employed in most instances with better results. . . . The accurate and minute classification of the cells constitutes the principal difficulty of the method. The proper distribution of the cells, however, into the principal classes is not so difficult, and for practical clinical purposes this probably suffices.

Arneth ('05), describing a "blood picture" from a case of acute miliary tuberculosis with 6,700 cells, as follows:

I	II	III	IV	V
42%	53%	5%	—	—

says:

Almost all the cells are crowded together in classes I and II, scarcely anything but young elements are available for the defense of the body, cells with slightly indented nuclei are heaped together, the older classes—III, IV, and V—are practically absent. The whole course of the case agreed

with this picture with almost mathematical accuracy, and with each new blood count a further deterioration of the blood picture could be seen until the end. All these important changes occur, let it be noted, in a patient who, according to former views, showed a leucopenia, and later a perfectly normal number of leucocytes.

Speaking of his chronic cases, he considers that, "despite a good temperature and a good general condition, a patient who shows an abnormal blood picture is far from approaching a cure." And further: "We should regard those cases as the most unfavorable with the most seriously altered blood picture and with a normal or nearly normal total number of cells, for in these the production of cells barely keeps pace with their destruction, and is not able to surpass it and produce a leucocytosis. . . . We are, therefore, justified in considering an increase in the total number of white cells as prognostically favorable." (This is in conflict with the views of Ullom and Craig.)

He quotes one case as an excellent example of the fact that a normal blood count as to numbers and a good general condition cannot be relied on if the blood picture is abnormal. In this case, in which there were 9,100 cells—51 in Class I, 46 in Class II, 2 in Class III, 1 in Class IV—the patient, on account of his very slight trouble, had already been selected from among the cases in Leube's clinic, from which Arneth's work comes, to be sent to a sanatorium, when suddenly he got worse with fever, severe hemorrhages, extension of the local process, and rapid deterioration of the general condition, and Arneth considers the case excellent evidence of the point he wishes to make. If his claims are verified by further study of other observers, we would evidently have a very valuable aid in the formation of a prognosis, and it is to be hoped that more studies will be made in this direction. I have now used Arneth's method in my laboratory for some time, and in about 100 cases, and while I cannot here report definitely on my results, I can say that on the whole I have found them to correspond closely with the claims of Arneth. Cases rapidly losing ground have uniformly shown a rapid movement to the left, bad cases at the first examination have always shown a marked tendency to a preponderance of classes I, II, and III, while favorable cases with good vitality have, on the contrary, almost always shown the reverse.

The technic is not difficult, but can be carried out by any careful man used to differential blood counting, and I am inclined to believe that it will prove a valuable method of estimating the resistance of a new case or of anticipating an advance of the process as yet not determinable by physical examination.

The bacteriologic study of the blood in tuberculosis has hitherto produced small results. The bacillus first found by Weichselbaum in

post-mortem blood clots in acute miliary tuberculosis was first discovered *intra vitam* by his pupil Meisel, and it has since been demonstrated in acute cases frequently but not in more chronic ones, and in a few cases of mixed infection streptococci have been found in the blood.

The chemistry of the blood has been studied by some, and Moraczewski ('03) has given the most recent complete study of the subject. The alkalinity is markedly decreased, and De Renzi believes that this favors the growth of the bacillus in the body. In the earlier stages the iron content is increased, though later decreased. In the first and second stages fibrin is increased, but decreased in the third, and the albumin content of the blood gradually lessens throughout the course.

In brief, Moraczewski's conclusions are that there is a decrease of coloring matter and of iron, a loss of serum albumin, a steady decrease of potassium salts, a development of cellulose, and a decrease at first, and later an increase, of sodium salts and chlorids.

Metabolism.—The metabolic changes in pulmonary tuberculosis are marked, as would be expected in a disease in which wasting is so prominent a symptom, and numerous observers have studied them carefully.

A comprehension of these alterations in the normal metabolism is by no means of purely theoretic or scientific interest, but is important to a proper understanding of the disease, and especially to a proper management of the feeding of patients, although, unfortunately, a scientific determination of a patient's nitrogenous balance is only possible under exceptional circumstances. In a work of this nature the metabolic changes can only be touched on in their most important aspects, the reader who is interested in the subject being referred to the special works on the subject (May, '03; Winternitz, '04).

In the human body, in health, those losses of weight which are produced by the normal tissue waste are compensated for, and the proper relation of ingesta to excreta (nutritive balance) is maintained by a proper dietary and by a normal functioning of all the organs. The oxidation of food produces heat and energy and prevents tissue waste, which else would have to occur in order to produce them. To keep up this constant production of heat and energy, and to allow of the building up of new tissue, the body must have supplied to it, through the digestive tract, proteids (nitrogenous substances), fats, and carbohydrates, not to mention salts and water. These substances, according to Rubner's law of calorific equivalents, or isodynamia, can in some degree substitute each other, but proteids are an essential element and cannot be substituted by either fats or carbohydrates. The necessary amount of proteids for an adult workingman is 118 gm. (483 cal.), 56 gm. (520 cal.) of fats, and of carbohydrates 500 gm. (2,050 cal.), making a daily requirement of about 3,000 calories (Voit).[1] If the

[1] From recent researches Chittenden ('05) believes himself justified to give the standard of proteid requirement as 56 gm.

food is not sufficient, the deficiency in heat must be supplied by the body, chiefly by the fat, which is the first tissue to show waste in denutrition. In superalimentation, on the contrary, the excess of fats and carbohydrates is deposited as fat, the excess of albumin being decomposed, the nitrogenous part being excreted as urea, while the nonnitrogenous part is thrown off by the respiration as CO_2 and H_2O, the normal albumin content of the body being but little changed.

Thus the nitrogen excreted in the urine is a measure of the albuminous destruction of the body, which normally equals the nitrogenous intake, while the nitrogen of the stools gives a measure of the nonabsorbed nitrogen. Thus an albuminous gain cannot be accomplished by an excessive proteid diet, but rather by the use of a diet rich in albumin, plus ample fat and carbohydrates, these better serving to economize the albumin of the body, and it is by such a proper mixed diet that the healthy man maintains a fairly constant standard of weight.

In active tuberculosis there is always an excess of outgo over income, more nitrogen by from 0.5 to 1 gm. being lost daily than is taken in, in average cases, while in severe cases of caseous pneumonia, where the waste is greatest, from the extensive cell destruction in the caseating areas, it can go as high as 12 gm. (Huppert and Riesell, '69). It is this waste which is compensatory for insufficient intake that gave the disease the name of consumption or phthisis.

The nutritive balance of such patients is upset. They suffer constant loss of nitrogen and of the calories necessary to carry on their economy, or, as Grancher-Barbier well puts it, "the patient is constantly obliged to draw on his resources of albumin if he is to succeed in building new leucocytes to destroy the infective agent and cicatrize his lesion."

The causes of this wasting are several: (1) poor absorptive power; (2) under-nourishment, due to poor appetite, which in turn is due to the effect of the poisons of the germ on the nervous system, producing lowered nutrition and thus favoring extension of the process; (3) increased tissue waste from expectoration and sweats; (4) effect of the toxins on the cells whose vitality and regenerative power is lessened thereby; (5) fever, due to the toxins.

These toxins are not only produced by the living germ, but are absorbed in large amounts from the necrotic areas into which they have diffused from the dead bacilli, this being the explanation of the unusual toxic effect in caseous pneumonia.

In periods of inactivity of the disease, the nutritive balance is probably normal, and in recovering cases the clinician has evidence of its restoration by the increasing brightness of the eye, the better nourishment of the skin, the filling out of hollows, and the increased snap and vitality which are impossible when the outgo surpasses the income, and

while gain of weight is not always a proof of a restoration of nutritive balance, since nitrogenous waste can continue even while fat is being deposited (May, '03), this is not common, and the clinician rightly regards these changes as the best possible evidences of the favorable progress of the patient, and his constant effort is to restore the balance of the economy and to increase the patient's weight and vitality. Only thus can the body cells be vitalized so as to carry on their fight against the invading organism, for on the vitality and fighting power of the cells entirely depend the chance of conquering the disease.

The poor absorptive power in tuberculosis was long ago noticed by F. Müller. In two cases of intestinal tuberculosis on milk diet, and in which he made careful estimations, he found respectively 40.2 per cent and 32.9 per cent of fat in the stools, whereas in a normal man he found only 10 per cent.

This poor absorption Winternitz thinks is not due to fever, von Noorden having found no difference in the absorptive power of a tuberculous patient during a prolonged afebrile period and during a period of fever produced by tuberculin, while Blumenfeld and Spirig ('96) in a series of very exact determinations found the absorption of both fat and lipanin excellent in tuberculosis without intestinal lesions. Therefore the lack of absorption may be ascribed to the intestinal lesions, but it should be remembered that frequently the physician will see early cases where no such lesions exist, and where large amounts of food are taken, and yet it is impossible to produce any gain of weight.

The amount of loss from sputum and sweats is probably not great, except in advanced cases, where they are very profuse. Lanz in 16 cases and Renk in 3 cases found a loss of from 5 per cent to 6 per cent of the total nitrogen, but as Ott ('03) notes these were advanced cases, and only in such he thinks could the sputum be a material source of nitrogenous loss. The solid portion of the sweats, of which, according to Argutinsky ('90), 70 per cent is urea, an end product of albuminous decomposition can deprive the body of considerable nitrogen, but here again this would not ordinarily be an active cause of loss.

The under-nourishment produced in tuberculosis by the anorexia is an active source of wasting, this anorexia being considered an effect of the toxins on the nerve terminals. Another cause of tissue waste, but according to May ('03) not a marked one, is cell destruction by the toxins, the index of this waste being the amount of organic phosphorus in the urine (Grancher-Barbier, Mitulescu).

A marked cause is the fever produced by the absorption of toxins. Van Noorden found that a nonfebrile tuberculous patient, getting a diet which furnished 43 calories per kilo, made slight gains in his nitrogenous balance, while, after a period of fever to 102° F. for six days,

he showed a nitrogenous loss varying from 0.58 to 3.54 gm. It should be noted, however, that while fever produces a large waste of albumin, its effect on fat is slight, loss of fat being chiefly due to under-nourishment, while in late cases the excess of muscular action produced by the dyspnea and chills is held responsible for the marked fat loss. To recapitulate, then, the chief causes of nitrogenous waste in tuberculosis are under-nourishment, the effects of the bacillary toxins, and fever.

The excretion of mineral substances in the urine in tuberculosis is an index of the cell destruction going on in the body, this having been especially emphasized by French authors, notably Robin and Binet ('01), who speak of the "demineralization" of the system in this disease as an early occurrence and consider it of great value in diagnosis. They consider that any excess of excretion of these bodies beyond the point where the total excretion of inorganic bodies is to the total dry residue as 30 to 100 (coefficient of demineralization) is pathologic and can be regarded as a sign of incipient tuberculosis. Ott ('02) and various German authors, however, while admitting a plus of excretion in advanced cases, deny its presence in early cases, and consider that it is due not, as Robin contends, to the toxic effects, but to under-nourishment, and points out that the French results rest on urinary analyses alone and do not include those of the feces.

The phosphorus compounds are abundant in the body, not only as calcium phosphate in the bones, but as lecithin and nuclein and proteid combinations, and their excretion in the urine the French consider an evidence of increased cell destruction, the cells being the carriers of nuclein and lecithin, which in turn get their phosphorus from the bones and muscles, and the excretion of phosphorus they believe to increase and decrease in direct relation to the advance and retrogression of the process in the lungs. Mitulescu ('03) has shown that where a negative nitrogenous balance exists, the excreted phosphoric acid exceeds the ingested phosphorus, the inorganic as well as the organic phosphorus being in excess. The phosphoric acid is chiefly found in combination with potash, soda, ammonia, lime and magnesia, and one third of it is excreted by the stools as calcium and magnesium phosphate and lecithin. Ott found that the excretion of phosphorus goes parallel with that of nitrogen.

An excess of lime excretion was at one time reported by Senator, but his results, depending only on an analysis of the urine, have been rejected by more recent writers. Croftan ('03) found an increase of calcium excretion in the urine combined with deutero-albumose, and believing that there is an affinity of this latter for calcium, and since deutero-albumose is found in calcifying tuberculous foci, he thinks that the use of calcium salts is indicated in tuberculosis.

In accordance with what is found in the blood, R. Meyer ('01), in Gerhardt's clinic, has found a complete reversal of the relation of the potassium and sodium excretion. Normally this relation is 1 gm. of potassium to 2 or 2.5 gm. of sodium, but in advanced phthisis he found the relation to be 3 gm. of K to 1 gm. of Na, although in early cases he found the relation normal. This he ascribes to the increased destruction of albumin in the tissues, especially the muscles.

Aside from the loss of nitrogen and mineral substances, tuberculous patients, with much intestinal trouble or with large purulent cavities, lose considerable amounts of indican through the urine. Albumoses are found in the urine chiefly in cavity cases and as the result of fever (Krehl and Matthes, '95). Acetone and diacetic acid is also found in old cases with much tissue destruction, according to Winternitz, but this is denied by Ott. Amyloid and fatty degeneration are the evidences of the deposit in the body of tissue waste. Hoppe-Seyler ('91) found an increase of urobilin after injections of tuberculin, and concludes from this that the toxins have the power to destroy red cells.

The gaseous metabolism in tuberculosis is but slightly, if at all, altered, the system accommodating itself to the lessened lung area, and, as is usual in the body, accomplishing the same amount of work with the decreased amount of tissue. The earlier experiments seemed to demonstrate a decreased CO_2 excretion, but later and much more accurate work by Moeller in Pettenkofer's clinic by A. Loewy ('91) and by Kraus and Chvostek ('91) have shown this last to have been incorrect. A moderate increase of oxygen intake and CO_2 excretion was found by these observers, but not to the extent taught by Robin and Binet ('01). These latter claimed a marked increase of respiratory exchange in tuberculosis in 92 per cent of their 392 cases, and they consider this an inherited tendency in those susceptible to the disease, and contrast it with the decreased exchange in gout and rheumatism. Loewy considers that an increase of oxygen intake and CO_2 excretion is evidence of an increased destruction of albumin but not of fat.

Winternitz, going over the same ground as Robin and Binet in afebrile cases, comes to the conclusion that cases of chronic afebrile tuberculosis have an oxygen consumption which, while within the limits of the normal, is somewhat high if the patient is emaciated or if there is much destruction of tissue, but if the nourishment is good, even if the process be advanced, it is strictly normal, and he considers that a plus of oxygen consumption in advanced cases is due to emaciation and to the increase of respiratory action, he having found the oxygen consumption proportionate to the degree of emaciation.

CHAPTER II

PHYSICAL EXAMINATION

By CHARLES L. MINOR

Physical Examination.—In the examination of an incipient case of pulmonary tuberculosis the most careful, thorough, painstaking work is demanded, and the frequent failure to diagnose the disease in its beginning is due chiefly to a lack of sufficient time and care in the examination. Physicians, accustomed chiefly to seeing acute diseases, do not always realize that the slight changes existing in early tuberculosis can produce at most only slight alterations from the normal, which can easily be overlooked unless an amount of time and pains be given to the examination which is not always necessary in more acute troubles. While a few great diagnostic experts, like the celebrated Oppolzer, of Vienna, can make a diagnosis in some cases with a glance and a touch, quickly and yet surely, such men will always be the exceptions, and, as a rule, it is safe to say that *good work cannot be done in a hurry* or without proper equipment and surroundings, and thus he who gives himself time and the right conditions, and follows a carefully determined routine in his work, will make correct diagnoses in many cases where the less painstaking will fail, and will discover small foci of trouble which else would be entirely overlooked.

Equipment of Examining Room.—The proper *equipment of the examining room* is a matter of real importance, and the physician will save time and increase the accuracy of his work by seeing to it that he has all the necessary apparatus close at hand, and so conveniently and systematically arranged that it can be used quickly and easily. This is the secret of the excellent diagnostic work done in large hospitals, infinite pains and proper equipment being used systematically; by reproducing these conditions the private practitioner can reproduce the results. Too commonly the physician has nothing ready; he must hunt up a stethoscope and tape, has no skin pencil at hand, no special table and examining stool, and has to use whatever comes handy.

Thus, following no set routine, and often not recording his results on a systematic form, he places perfectly needless handicaps on his nervous efficiency, decreases proportionately his powers of observation,

and, moreover, keeps no proper record for future reference. The examiner's mind should be entirely free to concentrate itself with intense earnestness on the problem before it, undisturbed by anything, and his body should be so relaxed and at rest as not to hamper him in the least. Few realize that for the most complete use of any faculty one must be entirely undisturbed not merely by outside noises, etc., but by strained positions or tense muscles, and that by avoiding these handicaps the keenness of hearing, sight, and touch can be greatly increased.

The Room.—The room should be quiet and as free from outside noises and disturbances or interruptions as possible. It should have, if feasible, northern light through large windows, and since the patient must be stripped to the waist it must be heated easily and rather more than comfortably warm—about 75° F. There should be a special table kept solely for the examination, and on which all needed instruments are conveniently arranged with a place for everything and everything in its place, and the writer has found the common glass-topped, glass-shelved, enameled iron ward table very good for this purpose. On it should be placed the regular stethoscope and any modified forms that we may wish to use for special cases, such as the phonendoscope or Bowles's stethoscope. There should also be a steel tape measure, a leather-covered lead tape, a pair of chest calipers, a skin pencil, colored pencils for recording findings, and a spatula and a jar of cold-cream vaselin to anoint dry, harsh, or hairy skins. Fixed on the table should be a paper clip to hold the examining chart steady, so that findings can be recorded easily.

Beside the table, with its back to the window, should be the physician's examining chair, the common laryngologist's chair with springy back being the best for this purpose. Facing this chair should be a stool for the patient, and I consider it a detail of real importance that this should be a rotating one, the ability to spin the patient around quickly to get at any part of the chest saving much time and often avoiding the use of strained attitudes. In order to be able to map out the stomach or to study Litten's diaphragmatic phenomenon a sofa is necessary. In addition, a height measure, permanently fastened to the wall, a reliable scale, and a wet spirometer are necessary.

Barring the laryngoscopic and Roentgen-ray outfits, this completes a list of all the essentials, and they are easily had and very cheap, so that no one who does any chest examining need be deprived of the great assistance they offer. The necessary equipment for a laryngeal, oral, and nasal examination (an aural examination is rarely needed) should be regarded as essential, and it is time the profession realized that no pulmonary examination can be said to be complete unless we know the condition of these vestibules of the lungs.

While a Roentgen-ray equipment is not essential, it is of very great value. If the Roentgen-ray is used the room must be made absolutely dark, and it is better to have for this purpose, and for the laryngeal examination, a special room with walls colored a dark red and with windows and doors so adjusted as to exclude the smallest ray of light.

Time of Examination.—This will usually, of necessity, be largely determined by the arrangement of the physician's day. However, in incipient cases where the detection of a few fine, isolated râles may be of great importance, the time immediately after waking, when there is most secretion in the lungs, is unquestionably the best time for examinations, as at such times one can hear râles which are entirely inaudible during the rest of the day. Such a time, however, for the full examination is not usually feasible except in special cases, in which case we should make a special visit to the patient's house early in the morning for this purpose.

The doctor should not undertake such examinations during his regular office hours while he is subject to many and constant interruptions, making concentrated consecutive thought impossible, and when the consciousness that other patients are impatiently waiting to see him is apt to tempt him to hurry through his work. He should, therefore, especially if he devotes himself particularly to such work, have an especial time of the day to make such examinations by appointment, when nothing will interrupt him and when he can concentrate himself on the work in hand.

The time necessary for a thorough examination varies considerably with the difficulties of the case and with the physician. A first examination, including a painstaking history, a laryngeal, fluoroscopic, and physical examination, demands at the very least one hour, often much more. Reëxaminations can be completed usually in from half an hour to forty-five minutes. Frequent reëxaminations are unnecessary and undesirable in tuberculosis, and the usual custom of monthly examinations, with such brief studies of the auscultatory findings in between as the developments of the case may demand, is ample, and chronic favorable cases with which we are thoroughly familiar can at times go two or three months without examinations, the changes in such cases being too gradual to render more frequent examinations of value. On the other hand, in active, acute, advancing cases the chest may need to be watched two or three times a week.

In setting a time for an examination, the menstrual period should be avoided in women, and routine examinations should not, if possible, be made in cases where the temperature is over 101° F. or during acute congestions, or even slight colds. Except in the case of patients who are too sick to leave the house, all regular examinations should be made

at the office, where the physician has at hand every convenience, and where much better work can be done than at the patient's house.

History.—Aside from the great importance for a correct diagnosis of a carefully taken and recorded history of the patient, a step that should be the beginning of every examination, the time thus occupied allows a patient to get over some of his natural excitement and to quiet down, and a tactful physician will take occasion to lay the foundations of relations of confidence with his patients at this time. Most, if not all, patients come to the office greatly excited, apprehensive, and wrought up, and this should, as far as possible, be allayed before beginning the physical examination. The presence of relatives and friends during the history taking, while at times adding useful facts to the history, often causes a patient to withhold valuable information as to his past life which, if alone, he will confide, and thus histories of past dissipations, syphilis, love affairs, family troubles, etc., which bear on the cases are missed. At the same time, relatives, especially wives or mothers, can often supply facts as to the patient's personality, past life, sickness, and family history, better than he, so that it is wise, after having taken the history with the patient alone, to have the relative come in and add any information possible.

A regular routine in the history taking should be followed to get histories systematic enough to be of value for reference, and while printed history forms are a great inconvenience by limiting one to a fixed space in every case, they are valuable since they prevent us from forgetting any of the many details to which we should turn our attention.

The recording of histories in bound volumes is a great mistake if we ever expect to use them for reference, the card index, using large sheets of very thin cardboard, being infinitely preferable. In private practice, no less than in sanatoria, facts as to birthplace, previous residences, various occupations, age, sex, condition, permanent address, should always be included if we hope ever to be able to follow up the future history of our cases.

The *family history* must be taken carefully if it is to be of any value. The general statement, so popular with patients when speaking of the health of their families, such as "all my family have been perfectly healthy," "none of my people have had lung trouble," etc., should never be accepted, but the health, age, cause of death of the paternal and maternal grandfathers, grandmothers, uncles, aunts, and first cousins, and of the father, mother, brothers, and sisters, should be inquired into individually. We should also investigate the possible existence on the paternal or maternal side of any marked tendency to dyspepsia, nervousness, anemia, or weak lungs. In this way we will often

discover cases of probable tuberculosis in the families of patients who have asserted that their family was entirely healthy, or it may reveal a tendency to gout and rheumatism which has a distinctly favorable prognostic value.

The rest of the history is best divided into sections on "Childhood History," one on "Past Life and Sicknesses," one on "Habits," one on "Present Sickness," and a statement as to the "Status Præsens," or existing conditions, at the time of examination.

The *childhood history* in women ends at the beginning of the female life, and in men the writer has found it practical to have it end at the time of going to college or into business. The condition of the home during childhood, as to its sanitary conditions, ought to be noted, as well as possible exposures to infections from sick relatives or others. Any exanthemata, especially measles, attacks of pertussis, pneumonia, pleurisy, bronchitis or tonsillitis, any enlarged cervical glands, otorrhea, and the childhood's habit of appetite and digestion—all are of value. The conditions of school or college life must always be investigated—the health of roommates, the ventilation of rooms, and the quality of the food all giving valuable information.

The *past life and sicknesses* should include the life from childhood up to the present trouble, and should bring out information as to the hygienic conditions of the houses lived in, and of the various occupations, possibilities of infection, marriage, and the health of wife and children, and all past sicknesses.

Habits is an important heading often omitted. From it we should try to get some idea of the exact mode of life and method of spending the time. The hours of work and the methods of work, the temperament and mental attitude, the average weight and best weight, appetite, digestion, sleep, and nerves, and any undue tendencies to catching cold, should all be noted, as well as past histories of malaria, neurasthenia, dyspepsia, pleurisies, etc., which without questioning the patient will often forget, and which can give a possible hint as to the commencement of the trouble. The information given under this head gives some idea of the life and personality of patients.

The Present Sickness.—The first question here, if we wish to find the real beginning of the trouble, should be not "When did your sickness begin," but "When were you last perfectly well?" for most patients have had a more or less extensive period of imperfect health before the development of symptoms sufficiently active to draw their attention to them, and by inquiring in this way we get a much earlier date for the beginning of the trouble than the patient would otherwise report. The average patient, when asked how long he has been sick, will usually date it back to the cough, cold, grip, hemoptysis, etc.,

that to him seemed to begin his sickness, whereas to the doctor it may date back from months to years before the present trouble, and may be separated from it by quite a period of good health. At such times a patient will generally report he was pale, somewhat off in weight, strength, or appetite, had a slight clearing of his throat, but with a little care he got over these symptoms and forgot them.

With these data and facts determined the patient should then be urged to give his own account of his trouble, only omitting, as far as we can induce him to do so, the many utterly irrelevant family details he usually wishes to mention. After this a few questions will make clear the course and development of the disease.

Finally, the *Status Præsens*, or actual condition at the time of examination, should be recorded for future comparison. We should note the amount of cough and expectoration, and the presence or absence of fever, sweats, chills, dyspnea, hoarseness, dysphagia, pallor, blood-spitting, the condition of the appetite, digestion, bowels, sleep, nervous system, the mental attitude, and the weight. A history so taken is invaluable for future reference or for scientific study.

The Examination.—If this is to yield the maximum of information, it must be carried out systematically, according to a logical plan, and to assure this the physician should have a well-designed chart whose routine he can follow in every case, and on which he records his findings. Only thus can even the most careful man avoid the omission of certain points and get records which are complete and of value for future study. The writer believes that each physician can do best, after consulting good standards, to plan his own chart, the cuts for which he can get from numerous books of reference and which can be made cheaply by almost any printing house in electroplate, and which can be printed for him under his own eye. Such a chart will probably be more useful to him than anything he can buy ready made. It must not be so small as to be crowded and awkward for reference, and should be of such a size that when folded once it will match the size of his history chart and be filed away with it.

There should be printed matter for recording the findings on inspection, palpation, and mensuration, as well as graphic outlines for recording the laryngologic findings. The Roentgen-ray, percussion, and auscultation findings should be recorded on three sets of outline pictures of the thorax from the front and from behind, but there should also be a place for writing a verbal description to supplement the graphic record, where that is necessary, since, whereas the graphic record is usually more valuable than a written one, there are times when only a written one can properly describe certain conditions.

It is best to begin the examination by taking the patient's weight

and height. Since we will usually have no opportunity to weigh patients naked, and since the weight of the usual clothing is fairly fixed, it is distinctly better to weigh the patient in his clothes. The height is taken in his shoes, from which subtract the height of his heels, which should always be measured, so as to get figures for the height that can be used in estimating the normal capacity and chest circumference, and the corpulence if this is desired. Since the vital capacity necessitates very deep breathing, it should best be postponed until the end of the examination.

Next in order should come the laryngeal, oral, and nasal examinations, and if there are any ear symptoms, an aural examination. Unfortunately, many physicians doubt their skill in laryngoscopy or rhinoscopy, and either omit this important step entirely, or, if marked laryngeal symptoms exist, send the patient to the laryngologist; but since a report from another as to existing conditions is of distinctly less value in the impression it produces on the mind than is the impression gotten by the use of our own eyes, this is much to be regretted. The information to be gained both for diagnosis and prognosis is of such value that every physician should master the simple technic, and this anyone who is willing to take a little trouble can do. When once this technic is mastered, a year or so of careful study of the larynx in every patient, with the use of a well-illustrated atlas of laryngoscopy, such as that of Krieg or of Grunwald, will enable him to recognize abnormal conditions and acquire sufficient diagnostic skill to greatly assist him in the study of his cases, while difficult or puzzling ones can still be referred to the specialist for final judgment.

Inspection of the mouth often gives a hint of syphilis; the condition of the teeth and gums can throw light on the causation of digestive troubles; unduly abundant adenoid tissue in the pharynx or enlarged tonsils give information as to the patient's constitution; while the discovery of an enlarged lingual tonsil, pressing on the epiglottis, will often clear up the causation of an obstinate, inexplicable cough.

An examination of the nose very often demonstrates an hypertrophy of one of the turbinates, the presence of polypi, a deflection or spur of the septum, resulting in obstruction to the free access of air to the lungs in nasal breathing, and gives a valuable therapeutic hint, the removal of such occlusions in these cases often having remarkably beneficial effects. Perforations of the septum will at times be found, and will explain abnormal breath sounds which this condition can produce. Posterior rhinoscopy is difficult to any but the specialist, but can be very useful in revealing adenoids. Laryngoscopy reveals some laryngeal abnormality (see Laryngeal Symptoms) in a large number of cases, and should under no circumstances be omitted.

The nose and throat examination being completed, and they need take but a very short time when once a physician is familiar with their technic and has acquired a familiarity with the normal and abnormal conditions, *the patient should be requested to undress to the waist.* In these days of accurate work it should not be necessary to insist on the absolute necessity of examining directly on the skin if we hope to get reliable results, but, though our German *confrères* have for years taught this, the American profession, especially when examining women, still very commonly neglect it, and I have heard good men maintain that they could listen as well through clothing as not. The latter statement is too diametrically opposed to the results of the best clinical experience to need refutation, and the claim that we will shock a patient's modesty is equally unsupportable.

The writer has for many years examined all patients stripped to the waist, the patients coming largely from the more refined walks of life, and he has yet to find any expressed objection to this most necessary step by any women except, strange to say, by a few who alone of all the number had no right to modesty at all, but in such women we do frequently find an appalling excess of modesty, which is most amusing. Doubtless, if the doctor hems and haws and seems embarrassed at asking the patient to undress, and does not go out of the room to give her an opportunity to do so, he would suggest to her the very feelings that he fears she may have, but if he goes about it directly and as a matter of course, he will find no trouble at all.

There should always be a light flannel shawl at hand to throw around the patient between the various steps of the examination, but none will object to its removal during the examination. Some patients are unduly afraid of catching cold, and having such a wrap handy reassures them, but, since we examine in an unduly warm room, this is a matter of imagination rather than fact, and the writer has seldom seen patients catch cold.

As to whether the Roentgen-ray examination should precede or follow the physical examination, is a question that will be differently settled, according as to whether the physician considers the one or the other the more reliable.

Personally, considering the Roentgen-ray as of inferior accuracy to the physical examination, the writer puts fluoroscopy first, so as not to find himself prepared to detect by it evidences of the lesions discovered by auscultation and percussion. After the Roentgen-ray examination, look for the physical signs which its findings have suggested. This is wiser than to reverse the procedure, for physical signs are of more value in forming an opinion than Roentgen-ray shadows. However, a description of the steps of the Roentgen-ray ex-

amination will be given later as being a newer and less important procedure.

The patient may assume either the standing, sitting, or lying-down position. Very sick patients must, of course, be examined lying down in their beds, but any patients who are able to come to the office should be examined in the upright posture, unless the recumbent position is indicated for special reasons, such as in a search for râles or in studying Litten's phenomenon or for an examination of the abdomen. While some physicians prefer to examine the patient standing, this is not desirable, as both the patient and the physician are thereby placed under more or less of a strain, and in nearly every case the sitting posture will be found the most satisfactory.

Inspection.—The room being properly warmed and the patient stripped to the waist, one proceeds to the inspection. For this step especially, which calls for the closest powers of observation on the physician's part, the patient should be seated stripped to the waist directly facing the window, best in diffuse bright daylight with each side equally illuminated. When first he seats himself, the patient should be allowed to take his natural posture, for in this way one will often get an excellent idea of habitual faults of position which call for correction. After this the patient should be made to sit erect, but not "strutting," in an easy upright pose.

First one notices the position and prominence of the clavicles and the condition of the supraclavicular and infraclavicular fossæ, the sternum, then the remainder of the anterior thorax should be observed for abnormalities. Slight flattening of the shoulder outline or shoulder droop must also be looked for, and the general build and form of the thorax, its length, breadth, and the angle of the ribs and breadth of the intercostal spaces noted. Posteriorly, one notes the position, height, and motion of the scapulæ, the fullness or flattening of the supraspinous muscles, and any possible scolioses or other spinal deformities. Then follows inspection for alterations of motion. This is done in two ways: First, facing the patient's front or back, and noting the relative upward motion on deep inspiration of the ribs and shoulders; then, standing behind the patient and looking down the anterior chest wall, observe the lifting of the ribs, outward and upward, and in this way one can note very slight differences of motion between the two sides.

Too hasty and cursory inspection is condemnable. Inspection is a valuable but a very delicate method, and one should observe very closely and carefully in order to profit fully from this procedure. In addition to inspection of the chest, note the patient's general build and nourishment, the condition of the skin and complexion, the condition of the pupils, hair, finger tips, nails, teeth, and gums, as well as the tongue and any existing dyspnea.

Palpation.—Palpation of the apical regions and of the first and second interspaces is best performed with the ulnar border of the hand, below that level applying the four fingers, evenly but not too firmly is better. Goldscheider ('07) recently recommended for orientation previous to his percussory determination of the absolute height of the apex the deep palpation between the heads of the sternocleidomastoid of the tubercle of the first rib, which is in definite relation to the apex. The writer has found this feasible in thin subjects, as well as in the determination of the inner border of the first rib, but the procedure is painful to the patient, as Goldscheider admits, and the information gained is not indispensable. While palpating, one should be sure to examine the neck for possible enlarged cervical glands, and the pulse for its tension.

As noted under "Blood-Pressure," finger estimations of tension are uniformly lower than would be expected from the readings such pulses give with the sphygmomanometer. Estimation of the pulse-rate during an examination is usually worthless, the patient being too excited and the heart beating abnormally. Palpation of the apex beat in very debilitated subjects is often difficult, the heart being very weak. Abdominal palpation, while usually neglected, may be useful in revealing dilated stomachs by splash, and enlarged mesenteric or retroperitoneal glands, but the abdomen of such patients is usually too tender to make glandular palpation easy.

Peritoneal friction may also be discovered in some cases of peritoneal tuberculosis. Sahli considers a firm lumpy band between the xiphoid and the umbilicus very characteristic of tuberculosis of the omentum.

Mensuration.—The weight and height are determined, as noted, before the patient undresses. The *estimation of the vital capacity* is best postponed until after auscultation, as the deep inspiration necessary may remove scanty râles. Most patients can be taught at the first trial how to fill the lungs fully, and then to exhale evenly, steadily, and completely into the spirometer, but a few, especially women patients, can never learn to use this instrument. The wet spirometer is the only reliable form. The use of the sphygmomanometer to test blood-pressure is not necessary as a regular part of the examination, the finger estimation of pressure being sufficient. The *tape*, for reasons of cleanliness, had best be of steel.

The measurement of the total circumference at extreme inspiration and extreme expiration is of little value, but the determination of the circumference of each half of the chest separately in inspiration and expiration is useful, often revealing limitations of motion confined to one side, or decreases in size. A smaller right half of the chest in

right-handed persons has some value in strengthening other signs. The total circumference when at rest should be noted to find out whether it is equal to one half the patient's height as it should be. For all tape measurements the anterior and posterior central lines should be marked on the sternum and spine at the level at which the tape is applied. The level to be preferred lies between the fourth ribs in front and the eighth dorsal spine behind, which two points should be marked by a cross or vertical line.

The *lead tape cyrtometer*, while it has fallen into disuse, is a most useful instrument, not simply in revealing often unsuspected asymmetry, but more especially in showing those shrinkages and reëxpansions of the thorax, which are so common in the disease, and which prognostically are of great value. The elaborate cyrtometers of the instrument makers are not necessary. A pair of simple calipers, capable of being opened to at least twelve inches, and a lead tape are all that is necessary. The latter can be made by any plumber from three-sixteenth sheet lead, and should be half an inch wide and tweny-six inches long, and for cleanliness had best be covered with calfskin by the shoemaker. The aim is to get a graphic record of the horizontal plane of the chest, vertical to its long axis, and so recorded that we can compare the tracings taken at one examination with those taken at another. I have found it convenient to use the instrument at the level of a plane cutting the fourth rib in front and the eighth dorsal spine behind, this plane being about at right angles to the axis of the thorax, being low enough to miss the scapula behind and the axillary folds.

The first step is to take the depth of the thorax between these points and lay it out on the chart, which should be large enough to hold the full tracing of the largest chest—i.e., twelve inches wide by sixteen inches long. Sitting facing the patient's left shoulder, pass the tape between the body and the right arm and place its posterior end carefully on the eighth spine, taking care thereafter that it does not slip from this point. It is then molded from behind forward to fit the chest snugly, being careful in crossing the axilla to follow its outline, and not arch across it as can be so easily done. As the tape is brought around toward the sternum it is best to roll the anterior end inward, which produces a better approximation. The snug fit of the tape and its correct position at the spine behind being verified, and any displacements of the skin being corrected, the patient's chest being in repose and not expanded, mark the point where it crosses the midline in front and remove it by raising its two ends and slipping it off the chest obliquely without bending. The depth of the chest having been laid out on a line which runs across the chart, the two ends of the tape are made to correspond with these marks, and the perimeter is then traced in colored pencil.

The left side, being similarly taken, is laid down opposite the right, the two adjoining end to end, and giving an accurate reproduction of the perimeter of the thorax. When this simple technic is once mastered it is easy to take absolutely accurate tracings, which will correspond with others taken the same day, or if the case is inactive and no change of form takes place, the tracings taken months or years apart will correspond accurately.

At reëxaminations the new tracings are not only traced on the new chart for that examination, but also over the old tracings, and marked in different colors, taking care to first lay out the depth by the calipers, as this may change between examinations. In this way we get very striking pictures of the increase or decrease in size of the patient's chest under treatment. Aside from its prognostic use it demonstrates very plainly flattenings or distortions of the thorax and differences in the two sides. Since the thorax is generally largest on the side of the arm used chiefly, a proper interpretation of tape measurements or lead-tape tracings and of percussion findings demands a note of the patient's right- or left-handedness, which should be marked on every chart.

Prognostically a progressive shrinkage of the perimeter during the course of the disease, except in old fibroid cases, where it is compatible with fair health and a relatively stationary trouble, is uniformly a bad sign. Expansion of the perimeter, on the contrary, especially if there is deepening of the anteroposterior diameter, is uniformly a good sign, and the writer has never known such expansion and deepening to occur except in improving cases. In incipient cases reëxpansion of the chest occurs first on the affected side, the good side, which has not had time to shrink, gaining little until later. In old cases, on the contrary, the least affected side is the first to show gains, which are evidently compensatory, and only later, if the patient improves, will expansion on the most affected side be found. In the slight scolioses so often seen in tuberculous patients, there is a bulging backward of the ribs on the side of the convexity, and if the patient is getting along well, and this scoliosis disappears, as it often does, the disappearance of this asymmetry is shown by the tracings.

Technic of Percussion.—In percussion one can use either the fingers alone or the percussion hammer and pleximeter. In this country the fingers are used almost universally. While in a few cases the hammer may be useful, in the large majority of cases the results of finger-finger percussion are much superior. The force of the blow is more under control, the note is purer and not complicated by the overtone of the pleximeter, valuable information is given by the sense of resistance in the parts, and there is less likelihood of percussing too hard.

Percussion, however, demands a perfect technic, and if the technic is poor the hammer will be preferable. A perfect technic can be acquired in a short time by practice, taking the piano hammer as a model—i. e., the blows must be vertical to the part percussed, the finger must rebound instantly, and the motion must be absolutely confined to the wrist and metacarpophalangeal joints, the rest of the arm being held perfectly motionless. This can be practiced by laying the forearm flat on the table top and practicing vertical blows on the table with the finger, the motion being necessarily limited to the joints mentioned. The middle finger is the best to use, for, being nearer the center of the hand, the blow is better balanced, and a vertical blow and a good recoil are thus more easily obtained, but the index finger can be used instead, or even the ring finger in an emergency. Except over very muscular backs, two fingers should never be used, as this favors unduly hard percussion and does not give a pure note (see Figs. 65, 66, 67).

Fig. 65.

Fig. 66.

Figs. 65 and 66.—Proper Position of the Fingers and Wrists, the Motions Being Altogether in the Wrist Joint and the Metacarpophalangeal Joint of the Second Finger of the Right Hand, the Blow Being Vertical, Light (65) and Rebounding (66), the Plexímeter Finger Being Laid in the Interspace Parallel to the Course of the Ribs.

The plexímeter may be any of the four fingers, though usually the middle finger, or the index of the left hand, is best, but over the apex, or when outlining areas with precision, or in children, or in subjects with narrow interspaces, the little finger is to be preferred. The finger must be applied evenly, but not too firmly; the blow of

the percussing finger *must never be oblique*, but absolutely vertical if the resultant note is to be pure, while the rebound must be instantaneous to allow of the vibration of the parts, except only in eliciting cracked-pot resonance, when it should remain in contact for a moment. The blows must be even in force, not too rapidly repeated, and in doubtful cases should occur during the same phase of respiration, since the note during inspiration and expiration is not identical. Usually two successive blows, regularly given, produce the best impression on the ear, but in cases where slight differences between the apices are suspected, single blows over each apex in turn are useful. It is also better, in doubtful cases, to percuss upward toward the diseased area rather than to begin over the impaired area and percuss downward, finer distinctions being obtainable in this way.

Fig. 67.—To Show the Use of the Little Finger in Delicate Percussion, in this Case, of the Outline of Apical Resonance. Percussion is here outward from the clear area toward the dull, but this can be reversed. Note the very moderate amount of wrist motion in light percussion, the chief motion being in the metacarpophalangeal joint.

Although every writer on the subject has dwelt on it, too much stress cannot be laid on the importance of light percussion in the large majority of cases and localities, the occasions when heavy percussion is needed being increasingly rare with increasing skill of percussion. No faults of percussion are so common as unduly heavy or oblique blows, and he who would percuss well must avoid them. The aim is not to produce the loudest sound possible, but the clearest and purest, and if the blow is quick, resilient, and very light, we will attain the best results, and added force will not increase, but lessen the clearness of the resulting sounds, and give rise to confusing vibrations from remote parts. Only when we desire to detect deep-seated foci of condensation, or when percussing over very thick layers of muscles or fat, should deep percussion be practiced, and the practice of hard percussion to reveal suspected tympany in the search for cavitation is absolutely useless, tympany so produced being more likely to come from deep-seated large bronchi than from excavations, while such violent blows can have a harmful effect on the diseased lung, and not infrequently produce hemorrhages.

The percussion should be of two kinds: (1) *Comparative*, in which alternate blows are delivered on corresponding parts of the two sides, and (2) *unilateral*, in which percussion is limited to one lung. Ordinarily percussion is best performed during shallow respiration, but comparative percussion during extreme inspiration and expiration is at times necessary to reveal slight differences. The patient should be seated easily erect, with his arms hanging by his side and his head strictly in midline for anterior percussion; with the arms on top of the head, and the elbows held well backward for axillary percussion; and bent forward moderately from the waist, not from the shoulders, with the head slightly drooped and the arms lightly crossed for posterior percussion. When the areas covered by the scapulæ are to be examined, the patient should place his fingers behind the posterior axillary folds on opposite sides, which will uncover all of the lung it is possible to get at. During percussion, positions which make the muscles tense or distort the symmetry of the thorax, such as straddling a chair, are to be avoided, the most undisturbed easy position always being best. Brown has noted that the volume of the percussion note can be increased by standing the patient in the angle between two walls.

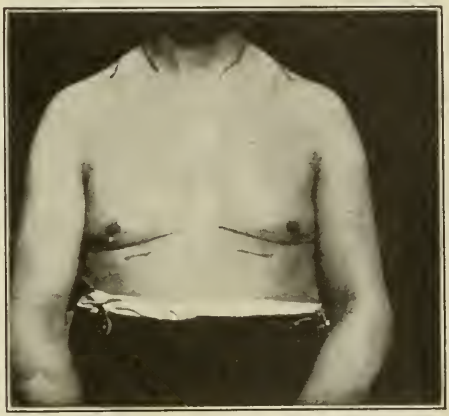


FIG. 68.

FIG. 69.

FIGS. 68 and 69.—FIBROID TUBERCULOSIS OF SIX YEARS' DURATION IN A MAN OF FIFTY-SIX IN WHICH THE FAT HIDES THE SHRINKAGE OF THE CHEST, WHICH IN ANY CASE IS MODERATE. Only the limitation of the resonant areas in the right apex are noticeable with slight limitation of motion at the right base.

The first step of a percussion should be the marking out of all the lung borders with a skin pencil, and this should be omitted from no

Fig. 70.

Fig. 71.

Figs. 70 and 71.—To Show the Deforming Effect of Pulmonary Tuberculosis upon the Thorax. Chest of an athlete, in which right-sided tuberculosis (stage II) had existed for two years. The shrinkage of the right side as compared to the left side is well shown, as also the falling in of the regions below the nipples. There is right shoulder droop, retraction of the right base and of the right apex. The flattening of the formerly prominent chest walls is well shown in the three quarters view.

examination, as it will greatly improve the accuracy of the work and guard against overlooking any portion of the lung in the examination. The base line should be marked all around during shallow breathing, while in the mammary line in front and in the scapular line behind the base line should be marked on deep inspiration, recording the excursion of the lower borders of the two lungs on the chart.

Apical Percussion. — The percussory projection of the apical outline ("isthmus") proposed by Kroenig ('89) the writer has practiced for a number of years, and has found it a very valuable procedure. The pathologic fact on which its value depends is the well-recognized tendency of the apex of the lung, and the lung as a whole, to shrink when a tuberculous focus develops in it, not alone from fibrosis, but even before any fibrosis occurs through the lessened functional activity produced by the disease. LeGrange has noted the rapid modification of the volume of the lung coincident with increase or decrease of function. Were apical shrinkage due to fibrosis alone, their determination would naturally be of no value in early diagnosis, but since the lung decreases in size when disused

or when disease is developing in it, such shrinkage becomes a valuable early sign. As great accuracy is desirable, the little finger is best used as a pleximeter, and the percussion stroke must be delivered very carefully and correctly, only the most perpendicular, elastic, light stroke being desirable, and the patient's head must be held exactly in the middle line to avoid uneven tension of the muscles.

Percussion of the inner anterior line should start well up the side of the neck above the lung, coming slowly downward until pulmonary resonance is found, the spot being marked by a dot with the skin pencil. Working from behind forward, the whole line is mapped out, which is slightly concave inward above, becoming rather convex inward in the lower third of its course, and ending rather indefinitely just external to the sternoclavicular joint, the bones here making accuracy difficult.

The outer border should be approached from the shoulder and marked in the same way. It is steeper than the inner and runs downward and outward, with its concavity outward to the junction of the inner and outer third of the clavicle. The posterior lines are marked in the same way. The normal level of the apex behind, according to Kroenig, is that of the first dorsal spine, and it is 2 to 2.4 inches outside the midline of

Fig. 72.

Fig. 73.

Figs. 72 and 73.—Tuberculosis of Left Apex. Note slight limitations of area of resonance at apex and of motion of left base. Also flattening of outline of anterior chest wall as shown in side view.

the spine. The inner line converges with its convexity toward the spinal column, until it reaches the level of the lower border of the second dorsal vertebra, when it runs downward parallel and half an inch from the spine. The posterior external line the writer has found to run downward with its concavity outward and to terminate with great regularity at the middle of the spine of the scapula. The lines having been percussed out, they should be inspected carefully, and even in very early cases there is often found some degree of dislocation inward of one or more of them. The dislocation is chiefly in the inner line, but dislocation of the outer line is also common, as the writer has determined again and again by careful percussion. In early cases the demarcation between resonance and dullness is less sharply pronounced than in the normal lung, being as it were "blurred."

Goldscheider ('07) recently objected to Kroenig's work on the ground that the resonant area thus outlined does not correspond to the anatomic apex, being only a projection field of lung resonance. This cannot be denied, but since these fields decrease in direct proportion to the contraction of the underlying lung, their determination does not thereby lose in clinical value, and, unlike Goldscheider's method, the outlining is sufficiently simple to be applied by anyone well skilled in percussion. Goldscheider, by the use of a bent-glass rod pleximeter, percusses out the absolute height of the apex anteriorly and posteriorly. After having used his instrument and method, the writer has found that the absolute area can be so percussed, but the method is much more complex and the results not more satisfactory than those of Kroenig.

The lung borders being marked out, the percussion of the lung should be commenced. This usually begins over the apices in the inner, middle, and outer zones in succession, comparing these from side to side, and thus small areas of dullness are often discovered that otherwise may be overlooked, one zone at times being dull when others are clear.

When, owing to emaciation, the supraclavicular fossa is a deep hole, percussion of the apices should take place from above and behind. We should also not omit to percuss the clavicle directly, without the use of a pleximeter, as at times this bone will give a dull note when above and below is clearness, and if we can exclude old fractures and unilateral abnormalities of the bone, such information is valuable.

The remainder of the chest should now be studied, taking pains to percuss absolutely symmetrical points and not to miss any portion of any interspace. Turban notes the necessity of not neglecting the apex of the axilla, a necessary warning, since, owing to motives of niceness, one is apt to avoid this region. The heart should always be mapped out on the anterior chest wall, care being taken not to overlook small areas of dullness on each side of the sternum, due to enlarged bronchial glands.

The back demands firmer percussion than the front, and in fat or very muscular persons percussion of this region may be most unsatisfactory. Small areas of dullness at the extreme base behind, from an

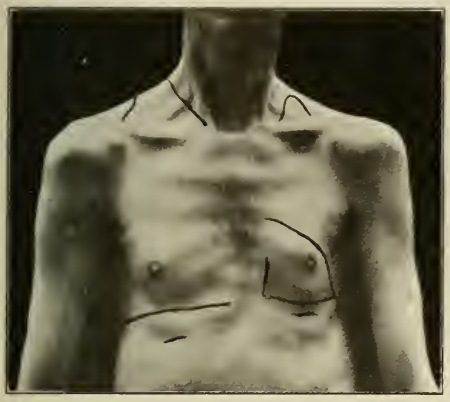


Fig. 74.

Fig. 75.

Fig. 76.

Fig. 77.

Figs. 74 to 77.—Typical Case of Fibroid Phthisis of Left Lung in Case of Four Years' Duration. Note shrinkage of left side, dislocation of heart to left (right border to left of sternum, apex five and one quarter inches outside midline). Extreme limitation of resonant area at left apex, anterior and posterior areas not joining, limit of motion of left base.

old pleurisy, are easily missed unless the bases are carefully marked. When scoliosis exists, producing abnormal arching of the ribs, percussion over such arched regions is more or less dull and percussion in scoliotic cases is not to be relied on implicitly.

Technic of Auscultation.—Usually and logically auscultation is the last step, as it is unquestionably the most important, of a physical exam-

ination, but some have advocated placing it first, so that the deep breathing necessitated by some of the preceding steps may not remove scanty adventitious sounds which may be of importance in diagnosis.

In doubtful incipient cases this may be necessary, but in such it is better, when the examination shows the case to be a suspicious one, and we suspect râles we cannot detect, to repeat the auscultation on another day, soon after the patient wakes, when such sounds are found most easily. Ordinarily it is best to place auscultation last, as this tends to give a more complete idea of the case, the various facts discovered by the other steps leading the mind logically onward and preparing it for a proper interpretation of the auscultatory findings, a knowledge of which enables us to correlate them into a complete whole. Moreover, if it is performed first, it tempts us to slur over the other steps which follow it, and we fail to get that broad view of the case which can only come from a consideration of all the discovered facts.

The *technic* of auscultation is simpler than is that of percussion, but it needs a careful training of the ear, and if the physician has a musical ear it will be of great assistance.

Auscultation may be either *immediate* or *mediate*. In the former the ear is laid directly on the chest, in the latter the sound is conveyed to the ear by an instrument, practically always a single or double tube. While the sound heard by immediate auscultation is very pure and gives an idea of the condition of a larger area of lung, it is faint, not sharply localized, and the finer adventitious sounds can be missed by it. Moreover, the ear cannot be placed in the supraclavicular fossa, and often not in the infraclavicular; the method brings one into disagreeably close contact with the patient's body, and it often necessitates very strained attitudes for the physician.

For these reasons mediate auscultation is the method most commonly used, but the other should not be neglected entirely, since certain types of breathing, notably bronchial, are heard more distinctly and typically by it, and it gives one an excellent general impression of the lung as a whole.

Mediate auscultation, devised by the great Laennec, is performed by the use of the *stethoscope*. This instrument is either for use with one ear (monaural) or with both ears (binaural), the former having been invented by Laennec in 1816, the latter by Dr. Camman, of New York, in 1840. The binaural stethoscope is in universal use in this country, the monaural on the Continent; and the clinicians of the Continent and those of America seem unable to agree as to the merits of these instruments. Aside from custom, whose large part in the settlement of this question for any individual practitioner should not be forgotten, the reasons which have caused the profession of this country to reject

the monaural stethoscope are: the very awkward and strained attitude necessary in its use, the inability to control its position and application by the eye, the difficulty of avoiding undue pressure upon it by the doctor's head, and the fact that the sounds it transmits, while pure, are unduly faint, and that certain sounds can escape entirely. Sahli criticises the binaural stethoscope for its complexity, for the false sounds which he considers are created in it, and for unduly magnifying and distorting the sounds which it transmits.

While some binaural stethoscopes are complex, the best type is practically as simple as the monaural, and if it is without joints, as a good stethoscope should be, it produces in itself no confusing sounds, and though it moderately magnifies the sound as heard by immediate auscultation, as well as the monaural, in a lesser degree, this magnification, if moderate (as it is in good instruments), is an advantage rather than a disadvantage. However, the chief advantage which the binaural stethoscope possesses is the fact that it allows the physician the maximum amount of ease and relaxation during his examination, and this, as noted elsewhere, is essential if he is to properly concentrate himself on the sounds to which he is listening. For these reasons, what follows refers entirely to the use of the binaural stethoscope and of the directly applied ear.

Various forms of binaural stethoscope have been invented, but the simplest is the best, and for this reason the writer prefers what the instrument dealers catalogue as *Snofton's English model*. This consists of a simple metal and hard-rubber chest piece, two metal conducting tubes connected by a curved spring, and hard-rubber ear pieces, the chest piece and ear pieces being united by rubber tubes. This instrument is extremely simple, and for all practical purposes as simple as the monaural.

In buying a stethoscope the physician should see to it that the curves of the tubes are such as to fit the axis of the canals of his ears, and that the shape of the rubber ear pieces is such as to accommodate itself well to his canals. The spring, while firm enough to keep the ear pieces in close contact with the ears, must not produce undue pressure. The chest piece, which is best made of hard rubber or ivory, screwing into metal, should not be over seven eighths of an inch in diameter, and its cavity can either be conical, the apex of the cone running into the two tube openings, or almost hemispherical, with one central opening at the top branching into the two tubes. The edge should be rounded, but not too thick. The rubber tubing which connects the chest piece with the ear piece should be perfectly flexible, yet thick enough not to kink when quite sharply bent. The only absolutely satisfactory tube for this purpose is a good, rather thick-walled, smooth stomach-tube. The

length of the tube should not be less than eight inches nor more than twelve, ten inches being the best, allowing amply for motion and change of position without kinking.

Stethoscopes meant to magnify the sound by the use of diaphragms, of which the *phonendoscope* is the best-known example, tend to lessen the acuity of the physician's hearing, though useful at times for auscultating indistinct sounds or for those who are hard of hearing. Of course every stethoscope magnifies somewhat, but the very moderate magnification found in such a stethoscope as advocated strikes the happy mean between the faintness of sound of the monaural and the undue loudness of the phonendoscope. Cabot recommends the Bowles' stethoscope, which differs from the instrument described in the chest piece, which is two inches in diameter, very slightly hollowed out, and covered with a hard-rubber diaphragm. It seems to share, in a lesser degree, the disadvantages of the phonendoscope, and to unduly magnify the sound, but Cabot says the diaphragm does not act in this way, since the instrument acts as well when it is cracked. In any case, in the choice of a stethoscope, *the important thing is that the physician should accustom himself thoroughly to the use of one instrument, and use that exclusively.* In this way any instrument will be found to yield satisfactory results, though the awkward positions necessitated by the monaural stethoscope are, to my mind, an irremovable handicap to its utility.

The only other instrumental equipment necessary in auscultation is a pot of cold cream vaselin and a spatula, which is often very necessary in anointing patients whose skins are harsh, scaly, or hairy.

Position.—The patient should be seated opposite and within easy reach of the physician, his hands hanging by his sides or lightly crossed in his lap, and his body in an easy, symmetrical position. The physician should be seated comfortably not too far from the patient, with absolute ease and relaxation on the part of the physician and the patient if the former is to absolutely concentrate his undivided attention on the sounds in the chest, undisturbed by uncomfortable or strained attitudes, and if the latter is not to produce muscular sounds in tense muscles.

Before beginning the auscultation, it is a matter of no little importance to listen carefully to the patient's method of breathing. The majority of patients produce some sound in their noses on moderately deep or deep breathing, or even sometimes on quiet breathing, these sounds being transmitted to the chest and affecting the pitch and quality of the expiratory and, less often, of the inspiratory sound. Opening the mouth is not always sufficient to cure this, many patients continuing, nevertheless, to breathe through the nose, others producing a loud bronchial sound in the throat, and a few a sibilant sound against the teeth. But if one will take pains to breathe properly for them, they will learn

quickly to respire normally and silently, even during deep breathing, by opening their mouths, and to maintain during deep breathing the normal relation of inspiration to expiration. Some patients, however, can never learn this, especially those with perforated septums, and such are very difficult to auscultate.

Having taught the patient how to breathe, and being sure that he is not cold, since this can produce shivering, and thus muscular sounds, the auscultation may be begun. It should always be carried out in two separate portions. First, directing attention entirely to the breath sounds, and neglecting any adventitious sounds, study their pitch, intensity, duration, rhythm, and quality. This should be comparative, exactly similar spots on each side from top to bottom of each lung being compared, inspiration with inspiration, expiration with expiration (Grancher), noting also the relation of inspiration to expiration.

By concentrating attention entirely on the breath sounds one scarcely hears any râles. Such comparative auscultation should first be made during quiet, easy breathing over the whole lung, and then during moderately deep breathing. Deep breathing should not be used in the auscultation of breath sounds, since during it they are never entirely normal, but moderately deep breathing, well performed, will at times reveal bronchovesicular breathing which would be missed on quiet breathing. Care must be taken to cover every portion of the lung area, the chest piece of the stethoscope being applied along the whole length of each interspace, not omitting the apex of the axilla, the pleural sinus, the body of the scapula, and the area of cardiac dullness.

Beginning over the apices whose inner, middle, and outer zones must be auscultated, proceed downward in slightly diverging lines so as to cover the whole anterior lateral and posterior aspects; in this way nothing will be missed. Finally, we should study the breath sounds in different portions of the same lung, noting the relations of inspiration to expiration, and remembering the normal variations in the sounds in various regions. Before completing comparative auscultation, vocal resonance must also be tested, remembering that it is best judged by the use of the whispered voice.

The results of the auscultation being noted on the chart while still fresh in mind, one should turn to the second portion of the auscultation, which the writer calls *unilateral auscultation*, in which attention is directed only to adventitious sounds. This is the most delicate part of auscultation, and demands the most concentrated attention. For this reason the patient should sit close beside the physician, but facing the other way, and close enough so that the stethoscope may easily be placed on any part of the chest. The type of breathing used should be, first, natural breathing, then moderately deep breathing, then very deep

breathing, and finally deep breathing preceded or followed by a short cough, râles which are absent at first often appearing on deeper breathing. Naturally, those râles heard easily on quiet breathing speak for a more advanced process than those which can only be elicited by deep or forced breathing. The writer usually has the patient cough just before taking a deep breath; Babcock, of Chicago, prefers to have the patient cough just at the end of a deep breath; Brown, of Saranac, has recently recommended cough following a complete expiration, and followed by a complete inspiration. If the cough precedes the breathing the patient must be told to avoid that act of swallowing after the cough which is natural with most people, and which can produce deceptive esophageal sounds. Of the râles heard, the phase of respiration in which they occur should be noted, as well as their size, their quality, and their appearance on natural or forced breathing. The physician should use some convenient system of signs for recording breath changes and adventitious sounds, thus simplifying his charts. Such a system will be found in the Appendix.

Technic of Roentgen Examination.—If used only occasionally, the information the fluoroscope can give hardly compensates for its great cost, and unless it is used frequently and systematically the physician will not develop sufficient skill in its use in chest work to avoid the many possible sources of error in interpreting the shadow picture, and he is apt, therefore, to be misled rather than helped by it. If, however, the physician will use the fluoroscope regularly in all his cases he will soon develop such a familiarity with it as to get from it great assistance.

The essentials are a dark room; a source of electric current, either to actuate the coil or to drive the plates of the static machine, though for the latter a water motor can be used; a device for interrupting the current, perfectly insulated conducting cords, a Roentgen-ray bulb, an adjustable stand to hold the bulb, a large fluorescent screen in a rectangular frame, and a large protective lead screen. The current can be obtained from an induction coil, or produced in a static machine, driven by electric or water motor, hand power being useless for practical work. The coil is more popular, being less bulky, not affected by weather, and yielding a powerful light. The static machine is preferable for fluoroscopy because of its steadier light, intensity after a certain point being a disadvantage rather than an advantage, and secondary in importance to steadiness because of the very greatly increased life of the tube, and the simpler and therefore much cheaper tube which can be used. It is also less likely to produce harmful effects on the patient (dermatitis) or physician (azoospermia).

If a coil is used it should be capable of producing from an eight- to a sixteen-inch spark; if a static machine, it must be well and strongly built,

with not less than eight thirty-inch revolving plates, and should produce at least a twelve-inch spark under good conditions, and must be run at at least 500 revolutions per minute. It must be kept in a dry room, and in damp weather kept dry by keeping calcium chlorid in the case. When once understood it should run every day in the year without difficulty.

An interrupter for use with a coil, or with a static machine a multiple spark-gap, is essential. Much of the failure to get proper results with the static machine has come from failure to heed Williams's advice to use a multiple spark-gap, the single spark-gap on the pole of the machine being entirely useless. By it the penetration of the tube can be raised or lowered at will, an essential thing in the study of the lungs, under different conditions or penetration, either to reveal areas of shadow invisible with high-vacuum tubes, or to penetrate thick chests, opaque until a series of sparks is introduced into the current.

The apparatus is simply a series of brass balls inserted in the course of the current, and so arranged that the current can be made to jump the gaps between a given number of balls at will. Each new gap inserted in the circuit raises the penetration of the tube, so that a tube of such low vacuum that it will not penetrate the chest at all can be raised until it acquires any necessary degree of penetration. This apparatus must be close by the observer's hand, so that he can make the changes instantaneously, and without removing his eyes from the screen.

The *cords* must be thickly and well insulated, as the high-tension current used will leak from ordinary ones. The *bulb* for thoracic work should be of the lowest vacuum that will give a clear picture. A bulb that will light up with a one-half-inch or a one-inch gap between the poles is satisfactory. Bulbs to be used with a coil need a heavy platinum cathode, with some arrangement for keeping the cathode cool, and an apparatus to lower the vacuum when it gets too high, since with a coil the vacuum rises very rapidly, until a nonadjustable tube is soon useless. Such tubes are very expensive and add greatly to the cost of apparatus.

With the static machine the cathode can be of light platinum, needs no cooling device, and, as the vacuum rises very slowly, an adjusting apparatus is not needed, such a tube lasting for a year or two in daily use, while for the same reason a six-inch tube is sufficiently large. Six-inch, light anode, nonadjustable tubes of the best make are very reasonable in price and are cheaper to use, until too high for satisfactory use, and then get a new one rather than buy expensive adjustable tubes. Laid aside for six months or a year, high tubes reduce their vacuum and can often be used again later. Care must be taken to choose bulbs carefully, seeing that they have a sharp focus—i. e., cast a clear-cut and

not a hazy or foggy shadow; so, if possible, a bulb should always be seen in action before being bought.

The *stand* must be firm, with a broad foot, and capable of easy and free adjustment to any angle and to the height of the chest of the tallest patient. A *lead screen*, in view of what we know of the effect of the Roentgen ray on the human body, is an important essential. The lead should be one sixteenth of an inch thick, three feet high by two feet wide, and mounted in a firm frame on an adjustable stand, and perforated by a circular four-inch hole, capable of being diaphragmed down to various smaller diameters. Such a screen, placed between the bulb and the patient, and about two inches from the bulb, cuts off all rays save those transluminating the thorax; it protects the patient as well as the physician from harmful effects.

The *fluorescent screen* should not be of the type usually furnished by supply houses, with a stereoscopelike eye piece or camera, but should be a large sheet of cardboard, sensitized by platino-cyanid of barium, sixteen by twelve inches in size, framed in wood, and with a handle at the middle of its longest side. With such a screen the whole thorax can be seen at once, and, since the work is done in a dark room, the camera is unnecessary and in the way.

The patient is best examined standing, though if too weak he may sit on a stool; patients so weak as to be obliged to recline are usually not in a position to leave their homes. While one can examine through the clothes, metal ornaments, objects in the pockets, buttons, etc., make so much trouble that it is better to examine the patient stripped. The two chief directions for illumination are anteroposterior and posteroanterior, but oblique examinations from one side in front to the other side behind, or vice versa, must not be forgotten, especially when examining the contents of the mediastinum. Except in oblique examinations, the axis of the rays must be at right angles to the transverse plane of the patient's chest to avoid distortion, very slight changes from an absolute right angle producing deceptive appearances.

The patient had best be placed about two feet from the cathode, or farther, as by placing him too close to the tube there results undue magnification of the shadows. The most useful level for the tube is that of the fourth rib at the sternum, but Holzknecht advises using also a higher and lower level. The physician should be in the dark, with his eyes closed, for about five minutes before he makes the examination, as when he comes directly from the light he is at first practically blind, and can see nothing at all, whereas if he gives his retina time to become sensitive in the dark, he will be able to see and study the shadow picture. If he comes from bright sunlight, more time may be necessary.

The beginner must be careful not to conclude quickly that a shadow

is pathologic, but must consider and exclude all possible sources of error, which, as noted, are numerous.

A regular order of observation should be followed, noting: *First*, the comparative size and shape of the two lung areas; *second*, the position and size of the heart; *third*, the mediastinal shadow and shadow of the roots of the lung; *fourth*, the motion of the bases; *fifth*, the clearness and size of the apices; *sixth*, any shadows in the body of the lungs.

The picture well seen and fixed in the memory, the physician should record it at once on his chart, reproducing, as closely as possible, the extent, shape, density, and nature of the shadows, and any bright spots he has observed; and while this has not, of course, the accuracy of a photographic plate, it is very satisfactory for clinical use, and enables one to keep a close watch on decrease and increase of areas of shading.

The physical examination having been completed, it remains for the physician to draw from it such conclusion as it justifies, and here the writer would warn not simply against making positive diagnoses in doubtful cases with few signs, but more especially against the far more dangerous and harmful fault of excluding tuberculosis because the first examination, even if made thoroughly and carefully, has proved negative. No clinician, however skillful, can be positive in such an exclusion after one examination, and since so much depends on it, and since the patient, comforted by such an assurance, will go back to his ordinary life, it is wiser to tell him that no positive signs were found and he is probably free from disease, but that it is preferable to watch him for two weeks or a month, studying his temperature, etc., and reëxamining him before giving a final opinion. After such a course one can feel fairly sure of his position, though faith in the diagnostic methods of modern medicine must never cause one to forget that in this life the absolute is always unattainable.

Again, one is often tempted or urged by the patient to give a prognosis after one examination, but the longer one treats tuberculosis the more wary will he become of making a positive prognosis. Again and again one sees cases that have impressed us favorably develop a rapid and destructive process, while cases which seem so desperate that we risk the statement that they will live at most two weeks or a month, will survive for one or two years, to be claimed by the Christian Scientists as cures or to remind us that prognosis, at best, is an uncertain art.

The study and combination of all the results of our examination should be noted carefully, and the small departures from the normal, revealed by the earlier steps, should not be neglected, but should be used to corroborate the findings given by the more important ones. It is desirable also to record on the charts at the time of the examination an opinion of the case while the impression made on the mind by the

different findings is fresh and sharp, for, however well these are recorded, reading them over will never reproduce at a subsequent date the clear impression obtained when the examination was just finished.

Finally, a note of warning should be sounded against yielding to the temptation when tired of omitting any part of the examination. Unquestionably, in some cases, certain steps can be omitted without affecting the result, but one can never tell just which these cases are, and there is not one step which in certain cases is not of the greatest value. Moreover, by commencing to omit certain steps, one enters on an easy but downward path that will surely lead into careless and slipshod work. *Facilis decensus Averni.*

CHAPTER III

DIAGNOSIS

By CHARLES L. MINOR

In these days, when pathology and clinical medicine are working together so effectively, the recognition of pulmonary tuberculosis need no longer be postponed until the disease is well advanced, and for the modern physician the diagnosis of this trouble means principally, and practically, its early diagnosis, and in what follows I shall pay attention chiefly to the discovery of the trouble in its incipiency.

When the disease has reached the stage which justifies the use of the term "consumption," its discovery makes no demands on our diagnostic skill, and offers little assistance to our therapeutic efforts, and the physician who hopes to be of use to his patient must remember that his results, save in acute or galloping cases, will be in direct proportion to the earliness of his diagnosis, and must be prepared to recognize the trouble in its very beginning, when the signs and symptoms, unless closely and logically studied, can be so ambiguous as to be confusing, and when he will, more often than not, be deprived of that absolute proof which can be given only by the discovery of the bacillus in the sputum.

Such an early diagnosis is often a difficult task, calling for the most careful clinical work, but such, fortunately, has been the advance of diagnostic methods, and such the improvement in medical education, that every physician who is willing to take the time and trouble, and to follow a proper system in his work, should be able to make the diagnosis, except possibly in a few unusual cases, and it should not so often as it is be left to the specialist to discover the patient's trouble.

The diagnosis of pulmonary tuberculosis is a result of the careful study of the facts yielded by three separate procedures, and not of any one of these alone—i. e., a history, a physical examination, and a study of the symptoms and clinical course of the case for a longer or shorter period—and can be fortified by the use of certain special procedures, such as the tuberculin test; but while we can thus reach practical certainty, it need hardly be stated that absolute certainty can only be attained by the discovery of the tubercle bacillus in the sputum. While,

however, this discovery can alone make an absolute diagnosis, it is by itself unable to make a complete one, and if such a complete diagnosis is desired the physician must make use of each of the procedures to which reference has been made. Moreover, one cannot too strongly dwell on the folly of postponing a diagnosis of pulmonary tuberculosis until the bacillus is discovered.

While it appears early in some cases, it is very frequently absent until the disease is well advanced, and when proper methods of physical examination can make us morally certain of the nature of the trouble, no one, therefore, should deprive his patient of the advantages of early treatment because he cannot demonstrate the germ.

The physical examination yields such valuable information that its findings are too often taken as final and sufficient in themselves, and a positive diagnosis made from them alone. This is an unwise practice, and no physician, however skillful, should in a doubtful case finally exclude tuberculosis after one examination, or until he is able to study together the facts gathered from a full and searching history, a thorough physical examination, and a study of the symptoms and clinical course of the case, followed, if necessary, by a reëxamination. Only thus can we venture to exclude tuberculosis, or sometimes diagnose it, in certain doubtful cases where bacilli are absent, and these are the very cases where it is most important that we should be sure of our position. Of course, in the large majority of cases, a positive diagnosis can be made without so much effort.

The **period of observation** is chiefly occupied with a careful study of the temperature, which should be taken every two hours during the day, and also on one or two nights, to reveal possible night fever. Moreover, since at such times certainty is important, it may be necessary to take the rectal temperature for a day or so to determine its relation to the mouth temperature, and the reliability of the latter. If the temperature proves normal, one or two excessive walks should be ordered, which will often reveal otherwise concealed fever (Penzoldt). If necessary, other doubtful symptoms can be studied, and if the sputum analysis has proved negative we can use special measures to demonstrate the bacillus. It need hardly be noted that, whatever his suspicions, the physician should try not to let his mind be prejudiced in favor of or against any special diagnosis, but should keep it open to conviction in any direction, not striving, like a special pleader, to make out a case at any cost, but, like the true scientist, seeking to discover the truth from the facts, however at variance it may prove to be with his preconceptions.

Since an absolute diagnosis depends on a discovery of the bacillus in the sputum or stools, this will be considered first.

Sputum Examination.—The best sputum for examination is usually that raised on awakening, coming as this does usually from the lung proper. When, however, the patient has some other chief time for clearing out his lungs, it should be collected then. In early doubtful cases, when little or no sputum is raised, the patient must carry around with him the sputum receptacle at all times so as to catch any chance expectoration that may be brought up.

In the morning the mouth is apt to be contaminated with saliva, etc., so that it should be well rinsed before spitting, to avoid any unnecessary contamination of the specimen, which should come from deep down in the chest, and not be hawked from the nose. The patient's statement that he raises nothing should not be accepted too quickly, as often by training he can be taught to furnish a specimen which he was unconsciously swallowing.

Furthermore, the fact that the sputum is only glairy or salivalike should not be a cause for rejection, if no other can be had, as at times numerous bacilli can be found in such mucoid sputum.

In the case of children, who cannot raise their sputum, but swallow it all, it may be necessary to administer an emetic on waking and search the vomitus for masses of sputum, and this may also be necessary in difficult cases with those adults, chiefly women, who swallow their sputum. It has lately been suggested that the fasting morning stomach be washed out for this purpose.

If there is no sputum, some advise giving potassium iodid for a while to produce bronchial secretion, but the very harmful effect of this drug on the pulmonary process, which I have frequently had opportunity to observe, leads me to think this an unwise procedure. The drinking of warm alkaline waters or the use of small doses of ipecac is harmless, but not very effectual. Usually three or four expectorations are sufficient, but in negative cases it may be necessary to save all the day's sputum and concentrate it if bacilli are to be found. This need not, however, be resorted to until frequently repeated examinations have failed to demonstrate the bacillus, and it need hardly be noted that not one, two, or even ten examinations suffice to exclude the possibility of tuberculosis, but that we are justified in believing the process very probably nontuberculous if very many repeated examinations are negative.

There are various methods of concentration, dependent on rendering homogeneous the total mass of the sputum by alkalies or digestive ferments and centrifugalizing the product. The writer has used with satisfaction the method recommended by Czaplewski, who considers the use of the stronger alkalies harmful to the staining qualities of the germ. He uses twelve per cent of borax, dissolved in hot distilled water to which an equal amount of boracic acid is added. This is filtered while warm,

and the excess of chemicals allowed to crystallize out. Of this two or three parts are taken to one part of sputum, these agitated together in a tall, stoppered cylindrical glass till homogeneous, when it is either sedimented for twenty-four hours or centrifuged.

The sputum should be collected in water-tight, wooden boxes, painted black inside. These are not only easily burned after use, unlike glass or metal receptacles, but the black surface and the wide opening permits picking out easily the particles to be examined, without removing the sputum from the box, which is both dirty and dangerous.

The sputum should be examined within a few hours of its expectoration, as otherwise many bacteria which often liquefy the whole mass, and change the appearance of the preparation, can develop. Once spread and fixed, the cover-glasses can be kept for a more convenient time, but the greatest care must be taken not to confuse different preparations, which, where many samples are being examined, is a very easy matter.

The porcelain dishes, used by architects for mixing their water colors, are very convenient for this purpose. The names of the patients are written in the different compartments with a skin pencil, and the cover-glasses are placed accordingly, the whole being covered by a bell glass to wait until a convenient time for examination. If boxes with black bottoms are not used, the sputum must be spread on some black surface to assist us in selecting proper portions for examination.

All authors speak of picking out the small rice masses or cheesy matter, but while these yield very large numbers of germs, they are never found in the sputum of early cases, which is usually mucoid, or mucopurulent, hence we have to satisfy ourselves in such with picking out the thickest, most purulent parts of the specimen, taking from each a small portion, mixing these all together intimately and taking the final lump from the mixture. In this way we lessen the chance of taking the sample from a part of the specimen free from germs, while they might be present in some other portion. Some sputums are remarkably tenacious and rubberlike, so that it is difficult to take up a portion on the platinum loop, but if this is heated the sputum will adhere to it easily. The portion taken must not be too large, else it will make a thick, dirty specimen, and will ooze out between the cover-glasses and soil the fingers. A piece the size of a No. 2 shot is sufficiently large. The sputum can be spread either on a cover-glass or on a glass slide. While the former method demands neater work, and the breaking of a cover-glass may soil the fingers, it yields better specimens. With a proper technic the fingers need never be soiled, or the glass broken, and when the examination is over, if the preparation is not to be preserved, the covers can be burned quickly in the Bunsen flame.

The best cover-glasses to use are those of medium thickness, seven-eighths of an inch square, round glasses being inconvenient and dirty to spread. The covers must be perfectly clean and fat free, which is best obtained by boiling them in ten per cent chromic-acid solution, washing them well in running water, and keeping them in ninety-five per cent alcohol.

The aim in spreading is to get a thin, even layer of sputum, so that the staining and decolorization can take place easily, and the study of the specimen be simplified. In order to accomplish this, place the proper amount of sputum in the center of a clean cover-glass, lay on the second cover-glass so that the corners do not coincide, and by gentle pressure between finger tips, combined with lateral movements, rub out the sputum to an even, thin layer, draw the covers apart, lightly warm them both over the Bunsen flame, thus drying the thinnest portion of the spread only, and continue this drying until the sputum is evenly spread on the two covers. The sputum may be rubbed out with a platinum spatula on one cover-glass, but the film is streaky, of varying thickness, and we get one cover instead of two for examination. If not dried fractionally, the spread covers must be dried in the air, or by holding them well above the Bunsen flame until perfectly dry, when they can be passed rapidly through the flame three times, more passages than this tending to burn the specimen and lessen its staining qualities.

Many stains may be used, but Ziehl-Neelson's is the best. This stain consists of a mixture of one part of a saturated alcoholic fuchsin and nine parts of a five per cent aqueous carbolic-acid solution, which is not permanent, and is best mixed fresh each time. The cover-glass is covered with stain, and it is then held over a Bunsen flame, until the fluid steams and sends off one or two bubbles, when it is laid aside for a minute or two, then drained and washed thoroughly in distilled water.

The decolorizing of the specimen, which aims to remove the stain from all the elements of the sputum except the tubercle bacillus, which is acid-resisting, is the essential feature of the whole staining procedure. Usually a dilute mineral acid is used. On the examination of urine or stools where smegma bacilli may be present, alcohol *must* be used in the decolorizing process, either with or after the acid, but in sputum work an aqueous solution is satisfactory.

Twenty per cent nitric or sulphuric acid is usually used, the latter, according to Czaplewski ('00), being the better, but these strengths must be handled carefully to avoid overdecolorization, though when their use is understood, they give beautiful results. Other decolorizers are Orth's hydrochloric-acid alcohol (1 per cent in 70 per cent alcohol), Ebner's fluid (2.5 parts hydrochloric acid, 2.5 parts sodium chlorate, and 100 parts distilled water mixed, to which add 500 parts 95 per cent alcohol), and sweet spirits of niter. Pure alcohol, while an excellent decolorizer, is too slow. Whatever solution is used, decolorization must not be carried too far. The cover-glass should be so placed in the fluid that every part is wet at once, and should be removed in a second to the water, which brings back the red color which was changed by immersion in the acid. This should be repeated until the proper color is gotten. The color to be aimed at is a faint pinkish-gray tint in the thin parts of the specimen. Washing well with 70 per cent alcohol is necessary if we wish to exclude smegma bacilli.

For counter-staining, either concentrated aqueous methylene-blue solu-

tion or Löffler's alkaline methylene blue is the best; methylene green makes a very beautiful contrast, but fades out very quickly in daylight. Methods which combine decolorization and counter-staining, such as that of Gabbett, prevent the control of the decolorizing process, hence are uncertain and should never be used. The counter-stain should act only one or two minutes, and the cover-glass should then be well washed and dried under filter paper and in the air till perfectly dry, as dampness will cause it to cloud. A properly prepared cover-glass should show a smooth, even spread, evenly stained a bright blue, with no thick streaks and no red spots.

The specimen is mounted in immersion oil (B. Fraenkel) and studied with a one-twelfth inch (2 mm.) oil immersion lens, a No. 4 Zeiss ocular, and a good condenser, Abbe's being very generally used with abundant light.

When numerous, the bacilli are easily found, but if they are scanty the search is often a long one. In a doubtful case a diagnosis should never be made on the discovery of one bacillus, unless it is absolutely typical in form, size, and peculiarities. If the result is negative, the sputum must be examined frequently and carefully, and if many such examinations are negative, we should homogenize the sputum.

Hesse puts streaks of sputum on a solidified Hayden's culture medium, which he places in an incubator, at blood temperature, and in five or six to twenty-four hours bacilli are found which before were undiscoverable.

By means of *animal inoculations* bacilli may be demonstrated when none can be found by the microscope. Intraperitoneal injections of suspensions of sputum in 2 or 3 c.c. of sterile saline solution are made in guinea pigs, which are killed in from three to seven weeks and carefully examined for anatomic or bacteriologic evidence of tuberculosis. Pure sputum may be inserted through small skin incisions in the groins, which incisions are then sealed with collodion. The inguinal glands swell in from eight to fourteen days in positive cases, and in from five to seven weeks the animal is killed and examined. Unfortunately, other bacteria in the sputum kill a large number of the animals very soon, especially in the intraperitoneal method, but if skillful observation is obtainable the results are positive and valuable.

In the case of children or others who swallow their sputum, a diagnosis may sometimes be made by an examination of the mucus flocculi from the stools, but intestinal tuberculosis must be excluded before a diagnosis of pulmonary tuberculosis is made.

Smegma bacilli can be differentiated by the fact that they decolorize easily in alcohol, unlike the tubercle bacillus. When treated with a saturated alcoholic solution of methylene blue they slowly turn blue, unlike the tubercle bacillus, having been deprived of their fuchsin by the alcohol, and thus being able to take up the counter-stain.

History.—The patient's history is of the greatest aid in making a diagnosis in a suspected case of pulmonary tuberculosis, but a carelessly

taken history is worse than useless, as it is misleading. F. Wolff ('94) places the history ahead of the physical examination. It will almost always prove that the trouble had its beginning long before the patient suspected himself to be sick, and gives information as to his family idiosyncrasies and constitution, his resistance to disease, and his opportunities for infection.

The Family History.—The discovery of one or two cases of tuberculosis in a patient's relatives has but little value, but a tuberculous father or mother, especially if they were sick during the patient's childhood, or tuberculous brothers or sisters, not only renders probable a decreased resistance to the disease, but, much more, demonstrates opportunities for infection in early life, when such infection is easiest. If many relatives have died of the disease, it is naturally both diagnostically and prognostically of importance, as is also information as to the course which the disease took in these persons.

The childhood history should show home and school conditions, opportunities for infection, as well as those sicknesses or states of health which favor or suggest the development of tuberculosis, such as measles, pertussis, scrofula, otitis, pleurisy, pneumonia, bronchitis, delicacy of constitution, sickliness, rickets, etc., and should also give an idea of the general health of the child.

The personal history can demonstrate not only unsuspected chances for infection in office, store, or workshop, where the abominable American habit of promiscuous spitting makes itself especially evident, but often reveals suspicious past sicknesses which masqueraded at the time as malaria, neurasthenia, or dyspepsia, or will reveal the occurrence of ischiorectal abscesses or pleurisies, which usually mean tuberculosis. Family, financial or other worries should also be inquired into if the patient is willing to be frank. The *habits*, by revealing the mode of life and of work, dissipations or idiosyncrasies, are of great value, and we should record the patient's norm as to appetite, weight, sleep, etc., as standards for comparison.

The present history, at least, is not apt to be neglected, but we must ascertain the real beginning of the present trouble and not merely the time when the symptoms became so marked as to draw the attention of the inattentive patient. A history of an old pneumonia or pleurisy, for instance, often serves to explain the physical signs found in the chest.

The status præsens, or present condition, giving the existing symptoms, is, of course, of the greatest value in diagnosis, and for further comparison and should always be recorded.

Physical Signs.—The facts revealed by a physical diagnosis have been fully dwelt on under Physical Signs. Here we will only consider briefly their relative value in diagnosis. *No physical sign in*

and by itself proves tuberculosis, and every sign can be produced by other conditions; hence a final diagnosis is impossible except after a synthesis, not simply of the facts yielded by the physical examination, but of those gathered from the history and a clinical study of the case; the practice of snap diagnoses based only on a brief physical examination, leads into error. Auscultation and percussion always show less than the full extent of the trouble, there always being an area outside the limit of abnormal sound where the disease is making inroads.

Inspection, if carefully performed, will in a large number of cases give a very good idea of the chief seat of the trouble and suggest its nature, but, as Babcock ('07) well says: "It is the detection of very slight differences . . . which is important." Thus pronounced deformities, faulty build, long flat chests, narrow angle, delicate skin, silky hair, etc., have value chiefly in prognosis, and are of but slight use in diagnosis. Often a first glance, revealing a slight flush of one cheek, is suggestive, although unilateral pupillary changes cannot be relied on, as also cannot Thompson's red line on the gums. In acute cases, cyanosis of the fingers without clubbing is ominous, as is an ashy gray pallor or widely dilated pupils.

Very slight flattening above the clavicle, combined with slight limitation of motion and slight shoulder droop, will be found very early in the disease. Flattening of the shoulder outline comes soon after these alterations as muscular wasting begins, and is accompanied by flattening below the clavicle and of the upper portion of the pectoralis. The more pronounced flattenings occur only after the diagnosis is almost self-evident, but from their nature one can at times suspect the presence of large cavities, or more especially the development of marked fibrosis. In the former case we will at times find localized hollowings in the upper one third of the chest in front, as in large shrinking cavities. In the latter there can be marked contraction and shortening of one side of the chest, producing concavity of its lateral outline and drawing the shoulder down toward the hip markedly.

Palpation is not of great value in diagnosis, and especially in early diagnosis, but a distinct increase of vocal fremitus, particularly on the left, can be used in corroborating other signs. Decrease of fremitus is too difficult to determine accurately to be of value. Small areas of increased fremitus at the bases behind or in front are useful in calling attention to slight areas of consolidation or pleuritic adhesion bands, which later steps will verify. The discovery of enlarged cervical glands is important, and if excitement from the examination can be excluded, tachycardia has the very greatest diagnostic value in very early cases. Distortion of the apex beat is also suggestive of fibrosis.

Mensuration is much more reliable prognostically than diagnostic-

ally, though the discovery of an undue shrinkage of the perimeter on one side of the chest by the lead tape can, in conjunction with other signs, enable us to decide in a difficult case which is the most seriously affected lung. The spirometer findings can at times have diagnostic value, an abnormally low vital capacity increasing the value of other findings, but usually it is the increase or decrease from time to time which is valuable, and then rather as an aid to prognosis.

Percussion.—Percussion changes do not appear as early as do changes in auscultation, but by very careful and light percussion great diagnostic assistance can be gathered in very early cases. Real dullness is never an early change, but a short or slightly high-pitched note, or slight tympany appears very early. In incipient cases one should be careful to study the apex in the three vertical zones already referred to, as one of these may be impaired while the others are still resonant. For this reason, if for no other, the marking out of the apical borders is of the greatest value. The posterior aspect of the apex, no less than the anterior, should receive light percussion, heavy percussion often failing to reveal the changes here that the other will demonstrate. Percussion directly on the clavicle must also not be neglected. It is important to hunt carefully for small isolated areas of impaired resonance, especially, as noted elsewhere, in the fourth interspace outside the left nipple line, or between the scapula and the spinal column low down, but we must be careful not to be misled by undue arching of the ribs, producing localized dullness.

Auscultation is recognized as the most accurate and delicate of diagnostic methods, and on it is placed reliance for the final rounding out and completion of the diagnosis.

The *breath changes* are not as positive diagnostically as are râles, but they appear earlier and combined with other signs, justify a positive diagnosis without waiting for the development of these latter, and if the physician will take care to study the various alterations of the respiratory murmur, he will not have to wait for adventitious sounds before he ventures to diagnose the trouble.

The sequence of these various alterations, in the writer's experience, is (1) rude or granular breathing, chiefly inspiratory; (2) feeble breathing; (3) cogwheel breathing; (4) harsh vesicular breathing and prolonged expiration; (5) vesiculobronchial or bronchovesicular breathing. Bronchial breathing is not an early sign. Transmission of the heart sounds to the right apex speaks for incipient consolidation. Grancher ('90) gives the order of the signs as (1) feeble; (2) rude; (3) cogwheel; (4) bronchovesicular; and Turban as (1) rude; (2) cogwheel; (3) harsh vesicular; (4) feeble, and (5) bronchovesicular. The value of vesiculobronchial breathing or harsh respiration at the right apex is, of course, less than when found at the

left, and many authorities teach that in young girls or women such a change has no diagnostic value, but while it must be accepted with great caution and must always be corroborated by other signs, its presence should cause one to use every possible care in seeking for more positive signs of trouble. The subclavian systolic murmur has no real diagnostic value. Changes in vocal resonance at times give information of beginning consolidation sooner than will percussion, and we should, therefore, be careful to test it, chiefly, however, by the use of the whispered voice, small isolated patches of bronchophony or whispered pectoriloquy revealing such patches as in a less degree can increase a vocal fremitus.

Râles.—The importance of râles in the diagnosis of pulmonary tuberculosis does not need to be insisted on. They cannot be called a very early sign, the process being diagnosticable for some time, and often for a long time, before they appear. Nevertheless, they must always be sought for with the greatest care, using forced breathing and cough, as well as those changes of position (horizontal) and of time (early morning) which favor their development. The use of potassium iodid is unwise, but the use of hot alkaline drinks, or of ipecac in small expectorant doses, is harmless and may be useful. Creosote preparations or ichthyol or alcohol will decrease the adventitious sounds so that in doubtful cases these drugs must be stopped for some days before the examination. When râles first appear they are usually isolated fine crepitations (dry crackles) not different from those of pneumonia, except in their scantiness, or, as Babcock thinks, in being less sharp and crackling. A few (often only one or two) such râles located in an apex, and discovered at various times (persistent), possibly disappearing after cough, but reappearing after some hours or a day, are, perhaps, the strongest diagnostic sign, though after an attack of grip an obstinate spot of apical catarrh can produce just such signs for a while. Even when not at an apex, persistent râles, accompanied by voice changes, have always a high significance, and foreshadow the future development of an area of involvement (Sokolowski). Indeed, the essential difference of the signs given by a tuberculous process from those given by those of any other catarrhal process is their persistence, and persisting pulmonary signs are always presumptively tuberculous.

Beginners must be on their guard against mistaking false râles of various sorts for the real ones. (See Physical Signs.) Fine sibilant râles at an apex, while by no means so diagnostic, are also, if persistent, very suggestive, as are a few isolated friction sounds, speaking for an apical pleurisy. With the appearance of fine moist râles (moist crackle, subcrepitant râle) the incipiency of the process is passed, and as it advances these râles increase in number and size, until they gradually develop, to terminate in a gurgle, that fatal sign which usually presages the approaching end. Some authors consider the mucous click, an isolated sticky, moist râle of medium size over an apex, diagnostic, but while it generally speaks for tuberculosis, it does not occur soon enough to be classed as an early diagnostic sign. The transient atelectatic râles often found at the bases posteriorly have no diagnostic value.

The *laryngeal examination* is in many cases of the greatest value diagnostically. When slight signs in the lungs have excited strong suspicions of tuberculosis, the discovery of a tablelike elevation of the mucous membrane of the posterior commissure, a reddened, swollen arytenoid, a unilateral cord paralysis (if aneurysm can be excluded), or even a pale and wrinkled posterior commissure, will transform an uncertainty into a certainty.

Fluoroscopy.—The fluoroscope is not a means of early diagnosis in most cases. At times it will show a contracted shaded apex when dullness or marked breath changes could not be discovered, but such findings are the exception.

Limitation of motion at the base (Williams) is much more common and is valuable, but too much diagnostic importance should not be placed upon it. In the early diagnosis of bronchial-gland enlargement, however, the fluoroscope far surpasses all other methods, and even if this instrument is not regularly used, all patients in whom this condition is suspected should be subjected to the X-ray for verification of the diagnosis.

Symptoms and Clinical Course.—The symptoms, like the physical signs, have been considered in detail and will here be only considered relative to diagnosis. In taking the history they should be inquired after most carefully, avoiding leading questions which might suggest the desired answer. It is often surprising to see how difficult it is for patients to give a rational and clear account of their symptoms and how anxious they are to substitute for a statement of facts that have come under their own observation, the diagnostic terms suggested to them by some friend or physician. The statement that a patient had "grip" should never be accepted, but he must be made to describe and enumerate the symptoms which led to this opinion, and very often it will be found that the grip was an exacerbation of a prœexisting tuberculosis, that a typhoid was an acute attack of the same, or a malaria only the chills and sweats of a pulmonary process.

Fever will not usually have been recognized by the patient in incipient cases, and he will have to be put on two-hourly measurements for from two to four weeks. In doing so a reliable thermometer is essential. Great assistance will be derived from making a graphic curve of the temperature and marking red lines across the chart at 97, 98, and 99, which makes much more striking rises above or falls below these points. A two-hourly record during the day should always be insisted on, and in suspicious cases night measurements at eight, twelve, and four may be necessary. Thus short-lived rises during the day and unsuspected night fever will be discovered. It is probable that some persons normally have a temperature above or below the usual limits, but as we rarely have an opportunity to learn the patient's normal curve, this cannot always be

determined. Persistent afternoon rises above 99.2° F. are very suspicious if the patient is at rest, and if above 99.6° F. and other causes can be excluded, it can be ascribed to tuberculosis, for, as Ruehle aptly says, "a persistent fever for which a reasonable cause cannot be found is most probably due to tuberculosis in the system." It must be remembered, however, that all men have some rise in temperature for about an hour after eating, and, therefore, temperatures taken after the midday meal must be over 100° F. to be of value (100.4° F., Penzoldt). The frequent premenstrual rise in women must not be forgotten when studying slight temperatures.

The curve in tuberculosis is fairly regular in early cases, and marked irregularities while the patient is at rest throw some suspicion on its tuberculous origin. The temperature may be normal for several days together, followed by periods when a constant slight afternoon temperature will be found, but two or four weeks of observation will clear this up. The rise in early cases rarely comes before one or two o'clock in the afternoon, and usually lasts but a short time, say to four or five o'clock, or even less, and the morning is marked by a fairly pronounced subnormal temperature, which has considerable diagnostic value. At this time morning temperatures of 96° F. and evening rises to 99° F., or rarely 100° F., are the rule, and greater rises would suggest a more advanced or more active trouble. At times when fever, discoverable by the thermometer, is absent, there is flushing of the cheeks after meals or on excitement, and this should always suggest the taking of a rectal temperature. When the temperature is pronounced, diagnosis by physical methods is usually easy. Patients with a dilated stomach and retention can run a suspicious temperature, which will entirely disappear on the correction of the gastric trouble, and this possibility should be kept in mind and the level of the lower border of the stomach determined.

Chills in early cases, unless the process is acute, are not found, and they are thus of value as suggesting the nature of the case.

Cyanosis of the fingers and face is likewise suggestive of acute trouble, but the cyanosis seen in clubbed fingers has no diagnostic value.

Languor is a common and early symptom and a very valuable one. It is too often explained by anything else rather than tuberculosis, such as neurasthenia, overwork, malaria, etc., but persistent languor should always excite attention.

Anorexia, when combined with other symptoms, adds weight to the suspicions.

Early tuberculosis often manifests itself as *dyspepsia* and a persistent sense of fullness and weight in the epigastrium, belching, discomfort, or other signs of fermentative dyspepsia, combined with wast-

ing and fatigue, are of great importance in diagnosis. *Ischiorectal abscess* should always suggest tuberculosis. The writer has never found diarrhea in very early cases, though it has been reported.

Sweats as an initial symptom are rare. They were present in one case seen by the writer as the only symptom, but were finally followed by rational signs.

Dyspnea, while present to a slight degree in some early cases, is not of value diagnostically except in acute disseminated cases, when marked dyspnea, out of proportion to the physical signs, would suggest extensive dissemination of tubercles. In a later stage of the trouble it is almost diagnostic of fibrosis.

Emaciation.—A persistent loss of weight is at times the first symptom, and always arouses the anxiety of the family and the physician. In such cases a suspicion of tuberculosis is justified if no other cause is found. Babcock ('07) states that men should weigh twenty-five pounds per foot and women twenty-three, and that any reduction below this is important in making a diagnosis. The method of Pignet of estimating the corpulence—i. e., the height in centimeters minus the sum of the chest circumference in centimeters, and the weight in kilos, which should yield a result under 25—is considered by Meissen a useful means of estimating the patient's resistance. Figures under 10 show a very strong constitution, those between 11 and 15 a strong one, those between 16 and 20 a good one, 21 to 25 a moderate one, 26 to 30 a weak one, 31 to 35 a very weak one, and over 35 a very bad one. Papillon gives the corpulence as the relation of the weight in hectogrammes to the height in centimeters, which he states must in girls be over three.

Hoarseness.—In a doubtful case a persistent hoarseness or clearing of the throat suggests weak lungs and demands a laryngeal and pulmonary examination.

Circulation, Blood.—Tachycardia, if persistent and unaffected by change of position from the erect to the recumbent (Wells) or paroxysmal on slight and trivial excitement is a common finding in tuberculosis, and a very valuable one in diagnosis, especially in the absence of fever, a pulse running persistently over 90 to 100 being suspicious. The tension of the pulse as a diagnostic factor has been insisted upon by Papillon especially, but while hypotension, combined with tachycardia, is suggestive, too many other conditions can affect the blood-pressure to make it of great value by itself. The morphology of the leucocytes cannot at present give any aid in diagnosis, though Arneth's work (see Blood) promises to lead to valuable developments in this line.

Pain.—Pain is not of great diagnostic value in early tuberculosis, but "rheumatism" of the shoulder at times means apical pleurisy, and a burning spot in a supraspinous fossa or pain in the point of the shoul-

der on cough is suggestive. At the same time it is unwise for the physician to belittle the importance of pain in regions where he cannot find any physical signs, for very often there will develop later at these sites evidences of trouble. Fullness and pain behind the sternum is at times found in tracheobronchial adenopathy. Head's painful spots have not proved of value, but pain on percussion over the apex will sometimes be found very early, and a sensitive apex is always highly suspicious.

Cough.—Cough is the symptom most commonly associated by the layman with this disease, and is rarely absent in any case. It appears very early and remains often long after all other symptoms have gone. It is first usually dry, and more of a "hack" or clearing of the throat than a real cough, such a "hack" as already noted being most suspicious, but often scarcely noted by the patient. Absence of cough is of much value in excluding tuberculosis, and a persistent cough which gets worse in summer and often does not disappear in winter, is with few exceptions due to tuberculosis, and while there can be a cough arising from irritation of the pneumogastric in the stomach justifying the term "stomach cough" so dear to the layman, this explanation should be accepted only after a careful stomach examination. Nervous cough may persist for long periods, but does not tend to change in character, as the tuberculous cough always does with a lapse of time.

Expectoration will often be absent in early cases. When present it strengthens the diagnostic value of cough as a symptom, even when no bacilli are found in it.

Hemorrhage.—Hemorrhage from any cause except tuberculosis is so rare that it is astonishing to see how diligently physicians seek to explain it as coming from any other possible cause, a practice that has been disastrous to many patients. At the same time, hemorrhage should not be regarded as of tuberculous origin without a conscientious effort to exclude other causes, notably heart disease (mitral stenosis principally, but also any other condition which can produce pulmonary engorgement). The expectorated blood in early and dubious cases should be examined carefully for bacilli, though even in tuberculosis they are not always found. Brown quotes with approval the method of Nattan-Larrier and Bergeron, in which twelve to twenty volumes of water are added to the blood before centrifuging as assisting the discovery of the germ. Small streaks and spots of blood in the sputum do not justify the term of hemorrhage, and can come after severe cough in ordinary bronchitis, but should cause the physician to keep his eye on the patient.

The nose and throat, on whose diagnosis so much depends, should be examined carefully in these early and doubtful cases to reveal bleeding points, and disease of the trachea must be excluded, as also other local and constitutional conditions, such as aneurysm, heart disease, hemo-

philia, etc. In incipient cases the exclusion of the gastric origin is not difficult. It only becomes difficult in large hemorrhages, where much blood has been vomited and swallowed. Cornet says ('07): "However numerous the causes may be, we will seldom go wrong when the patient feels a tickling in his throat and brings up, with a violent coughing fit, foamy, aërated blood (one or two teaspoonfuls or much more) in considering the case tuberculous, and treating it as such until the contrary is proven."

Other Diagnostic Measures.—When we have exhausted all the usual steps of an examination, including repeated sputum examinations, and find no evidence of tuberculosis, we should be content with the negative result, it being neither necessary nor wise to go further, but in some cases the history or the signs will be very suspicious, while not conclusive, and it may be very important in these cases to find some other means of arriving at a diagnosis. Of these other means, the first and most important one is:

The Tuberculin Test.—This test, as a means of completing the diagnosis of a doubtful case, has been before the profession for a number of years, but only recently has the fear of this preparation which resulted from its abuse at the time of its discovery, calmed sufficiently, as the result of a painstaking study of its value by such men as Petruschky, Turban, Cornet, Bandelier, and others in Germany, and in this country by Trudeau, Baldwin, A. C. Klebs, Otis, and others, to allow of any considerable use of this method by the profession. The neglect was unquestionably due to a fear lest it might tend to aggravate or disseminate the process, as was taught by Virchow, but while the preparation is a powerful one, and needs the most careful handling, the work of innumerable careful observers has demonstrated satisfactorily that *tuberculin, carefully used in proper doses in properly selected cases, is free from harmful effects,* and while some of the best workers in this line are still ultra-conservative as to it (Sokolowski, Meissen), and while it should never be resorted to until all other means of making a diagnosis have failed, it is safe to teach that no strongly suspicious case should go undiagnosed because of a fear of the danger of tuberculin. Osler said: "An important point is its harmlessness. I remember no cases in which injurious results have followed the injection," and this is to-day the view of such a majority of the leading clinicians that no physician need fear to recommend its use to his patients if properly applied.

The question is, however, does a positive reaction always demonstrate the existence of tuberculosis, or a negative one always exclude it? An absolute, positive, and negative diagnostic measure it certainly is not. As M. Wolff says, "an absolutely easily applied method for the certain

determination of beginning tuberculosis . . . would be almost as valuable to us as a specific," but a method to be useful need not claim to be absolute, and the test yields such a large per cent (eighty-five to ninety per cent) of reliable results as to make it of the greatest value in diagnosis. The work of no one man, however extensive, could alone serve to decide the question of the diagnostic value of this test, but only by a consideration of the results of the work of many men can it be answered.

Since 1890 the tuberculin test has been used in a great number of cases in human beings, not to mention its use in cattle, where it has a greater diagnostic value than in man (over ninety-seven per cent, A. Fraenkel, Nocard), and a study of the results of all this work proves that a positive reaction to the tuberculin test, if the dose is not too large, justifies the diagnosis of the existence of tuberculosis in the patient, while a failure to react casts great suspicion on the tuberculous nature of the process if we can exclude old healed lesions or advanced trouble, both of which can fail to react.

Those interested in the statistics should refer to the literature of the subject. It is to-day considered that from eighty-five to ninety per cent of cases of tuberculosis will react positively, suspicious cases included, and that very nearly a hundred per cent of first- and second-stage cases which are demonstrably tuberculous will react to the test (Beck). Brown states: "No case of early or incipient pulmonary tuberculosis has been shown to fail to react to a dose of 0.01 c.c. (10 mgm.) or less of old tuberculin." Dunn ('03), of Asheville, who has a very large experience with tuberculin, says: "The test is a safe, reliable, practical, and justifiable diagnostic resource in those cases in which its use is indicated." Turban, who has had a very large experience with it for a number of years, states that a pronounced reaction is never noted in the healthy, or in other diseases, but this is too wide a statement, and despite the statement of Brown that "no case of syphilis, actinomycosis, leprosy, or chlorosis, which reacted to tuberculin, has been proved at post mortem to be free from tuberculosis," the work of Otis ('01) and others justifies the belief that fresh syphilis can give this reaction, and even such enthusiastic advocates of tuberculin as Bandelier and Roepke admit that probably syphilities will react. Of course, it must be remembered that modern work has shown (Naegeli, etc.) that a large number of people have a latent tuberculosis, and that thus positive reactions in those having other diseases may well be due to such concealed foci in the system, but whether such foci exist can only be determined by post mortems, and unless such are available the results of careful clinical work must decide whether the patient has tuberculosis or not, and a positive reaction to tuberculin,

unaccompanied by any clinical evidences of disease, should not lead us to declare the patient to be clinically tuberculous, but should demand careful and prolonged study of the case.

While, however, tuberculin is not an absolute proof of tuberculosis, the fact that it is positive in eighty or ninety per cent of the cases makes it an invaluable addition to our diagnostic armamentarium, and in cases with very dubious signs it is more positive than anything except the discovery of bacilli in the sputum, and the physician is safe in assuming that any patient whose symptoms and signs justify the use of the test, reacting distinctly to a moderate dose of tuberculin, is tuberculous. Likewise, if such a patient fails to react after a repetition of the final dose, he is justified in considering that, barring a possible encapsulated, healed focus, the patient is probably free of tuberculosis.

Technic.—While any of the various preparations of tuberculin can produce the reaction, Koch's old tuberculin is now universally used for diagnostic purposes, and, as in diagnostic work, uniformity of procedure is most desirable, the use of any other product cannot be considered wise. The old tuberculin is now made in excellent quality in this country, and for a long time was made and most generously supplied to the profession by the Saranac Laboratories under Drs. Trudeau and Baldwin. It is a sirupy, light-brown fluid which, while undiluted, is permanent. Brown wisely draws attention to the fact that the strength of tuberculin is far from constant, even when made by the same process, so that it should always be carefully standardized. Dunn ('03) reports a case exemplifying the variability of different samples of the drug, in which 5 mgm. of one preparation produced neither recognizable, local, nor general reaction, but in which, after the proper interval, the use of 2.5 mgm. of another preparation, which had shown itself unusually active, gave a marked general reaction.

For use it is diluted under strict aseptic precautions with 0.5 to 0.25 per cent carbolic acid in distilled water, or normal salt solution, using pipettes graduated in cubic centimeters and tenths of a cubic centimeter. The dilutions needed are two: one of 1 per cent and one of $\frac{1}{10}$ per cent, and these will last for a week at least if kept in the dark. The 1-per-cent solution contains in $\frac{1}{10}$ c.c. (one division of the usual hypodermic syringe containing 1 c.c.) 1 mgm. of tuberculin and the $\frac{1}{10}$-per-cent solution contains in $\frac{1}{10}$ c.c. $\frac{1}{10}$ mgm. Thus, by diluting measured quantities of the fluid with the carbolic-acid solution, and using one or more tenths of this dilution, we can get any dose from $\frac{1}{100}$ mgm. up to 10 mgm., hence no others are needed for diagnostic purposes. For example, in preparing a dose of $\frac{5}{100}$ mgm. we suck $\frac{1}{10}$ of a cubic centimeter of the $\frac{1}{10}$-per-cent solution into the syringe (one division), this equaling $\frac{1}{10}$ mgm. of tuberculin, and dilute it with $\frac{9}{10}$

c.c. of a carbolic-acid solution, each division of the mixture therefore equaling $\frac{1}{100}$ mgm. of tuberculin, and, of course, five divisions contain the $\frac{5}{100}$ mgm. of it. The syringe must be sterile, and is best kept in 1-per-cent carbolic water, or, if made of glass, in alcohol. The needle should be boiled before use.

The usually chosen *site for the injection* is under the angle of the scapula, but any convenient region can be used. The site is cleaned with alcohol. The writer prefers driving the needle vertically into the muscles up to its socket, which avoids all veins and is less painful than the subcutaneous method. While cleanly injection prevents any abscess formation, a local reaction around the site of injection—i. e., some redness and tenderness and stiffness—occasionally occurs, but never goes any further than this. Some have advocated the patient's going to bed for twenty-four hours after the injection, but this is not necessary unless strong reaction occurs, although the next day should be spent quietly in a reclining chair.

Since nervous patients can very easily produce the symptoms which they are led to anticipate, it is important in diagnostic cases not to let them know what you expect. Three days or a week preceding the injection should be given up to a two-hour study of the temperature and a record made of the exact pulmonary findings, for it is only by a comparison with the norm that the method has value. After the injection the temperature must be taken two hourly in the daytime for thirty-six hours, and the chest watched for local signs.

Dosage.—There is considerable difference of opinion as to the best doses, but fair uniformity as to its maximum and minimum limits. Koch originally recommended an initial dose of 1 mgm., followed in two days by 5, and this by 10, with a repetition of the last dose, if negative. Turban uses 0.5 mgm., 2 mgm., 5 mgm.; Cornet, 1 mgm., 3 mgm., 5 to 6 mgm.; L. Brown recommends $\frac{1}{2}$ mgm., 1, 3, 5, and 8 mgm. M. Wolff begins with $\frac{1}{10}$ mgm., then $\frac{5}{10}$ mgm., then 1, 2, 5, and 10 mgm. Roepke uses $\frac{2}{10}$, 1, and 5. Petruschky, in young people or children, advises $\frac{1}{10}$, $\frac{5}{10}$, 2, and 5 mgm. Loewenstein and Kauffmann ('06) advocate a different plan, using a dose of $\frac{2}{10}$ mgm., repeated at three-day intervals, four doses, and then, if necessary, though this they think will rarely be the case, 2, 5, and 10 mgm. The hypersusceptibility created in the body by one dose is the fact on which they rely in the use of these repeated small doses, believing that in this way the small doses are raised to the value of larger ones.[1] Others have suggested that such repeated small doses might create an immunity and so defeat the test,

[1] This hypersusceptibility is the same as that produced in the body by the tubercle bacillus and its products, on which the tuberculin test depends.

hence this method has not met the approval of most experts in this work. There is certainly no harm, and there are many advantages, in a moderate initial dose, and the writer favors $\frac{2}{10}$ mgm. for a beginning dose, followed by 1, 2, and 5 mgm., which will usually be satisfactory; while if this is negative and the patient is strong we can use an 8 or 10 mgm. dose, repeated once. More than 10 mgm. should never be used. If one dose produces a mild, indefinite reaction, the same dose should be repeated in two days, when it will frequently result positively and distinctly. Koch considers a strong reaction, following a repetition of the dose, as especially characteristic, and believes that this may be regarded as a quite infallible sign of the presence of tuberculosis.

In view of the fact that the reaction can be delayed for thirty hours, or even more, it is essential that two days elapse between the doses, and some authors advocate an interval of three days. It should never be forgotten that reaction to tuberculin is not limited to the tuberculous if the dose be large enough, the tuberculous person differing from the normal not in reacting but in reacting to small doses, and it is therefore of the utmost importance that the largest diagnostic dose shall never be large enough to produce a reaction in a normal person. Koch has set this maximum at 10 mgm., and while reactions will usually be obtained with smaller doses, most authorities are united in considering that a reaction to 10 mgm. will not occur in the normal man.

The usual *time for injection*, and that recommended by Koch and others, is as late in the evening as possible, so that any possible temperature rises in the night should not be missed, but Bandelier and Roepke ('08), who have had a very large experience, advise injections between eight and ten in the morning, since most reactions come in six to eight hours. The dosage in children must be smaller than in adults by $\frac{1}{2}$ to $\frac{1}{10}$, usually $\frac{1}{10}$ mgm.; $\frac{5}{10}$, 1, and 3 mgm. are advisable. Koch is very particular in insisting on ascertaining the normal temperature of the patient before the beginning of the test, and believes that the temperature must not go over 99.1° F. in the afternoon. Brown, and also W. L. Dunn, believe that 100° F. is not too high a limit in the hands of one experienced with the method.

The Reaction.—This is local and general. The former is the specific feature of the reaction, and is due to congestion around the tuberculous focus, probably resulting (Citron) from the combination of the tuberculin in the blood and the antibodies in the focus.

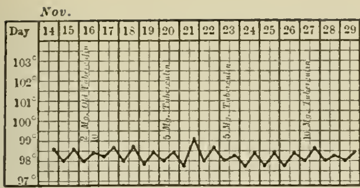
If the lesion is visible (skin, larynx) this reaction is manifested by redness and swelling, and, if concealed, by an increase of physical signs, the result of the engorgement and swelling around the lesion. Turban considers the signs of a local reaction in the lung as the most valuable

part of the test, and watches the patient daily for the development or increase of dullness, breath changes, and especially râles, but while such local signs, when found, are very valuable, they are often absent and are not essential to a diagnosis. The cough and sputum are naturally also increased, and bacilli which have been absent may appear, hence Turban advises the careful collection of all the sputum during the test.

The general reaction is not specific, since sufficiently large doses of tuberculin produce a reaction in normal people. It is manifested by fever and constitutional symptoms, and is not different from the effects of any other bacterial toxins on the human system. The patient feels badly, complains of headache and chilly sensations, or has a definite chill, his joints ache, he feels weary, loses appetite, and has a rapid pulse, and at times will develop nausea and vomiting. If tuberculous glands are concealed in the body they will frequently be revealed in this way. The writer has known areas of localized tenderness in the abdomen to suggest probable intra-abdominal glands. The temperature rise may be slight, moderate, or great, but usually runs from 100° plus to 103° F. (see accompanying charts).

A reaction with temperature not over 100.5° F., and with few constitutional symptoms, is called mild, one in which the temperature runs from 100.5° to 102° F., with more pronounced symptoms, is considered medium, and one with fever above this point accompanied by marked prostration is considered severe. A rise to less than 100° F. (Roepke, 100.4° F.), unless supported by a local reaction, when a rise of 1° F. is enough, should not be considered diagnostic, but should call for a repetition of the dose.

While the reaction may begin in four hours or be postponed for thirty-six, most reactions occur in from six to eight hours, or slightly more, and persist for from six to twelve hours, then disappearing rapidly, and leaving behind only a sense of fatigue for a little while, until by the third day the patient is himself again, and often feels better than before. Very early (under four hours) or very late reactions (after forty hours) should be excluded from consideration, as not resulting from the injection. In the very nervous, whose excitability can give them slight rises, it is at times necessary to make the first dose of sterile water, or five-per-cent carbolic solution, to exclude this "nervous temperature." A positive and distinct reaction, if accompanied with other suspicious signs or symptoms, justifies, as already said, a diagnosis. To quote Petruschky ('00), one of the most faithful students of this subject, "if several times typical reactions follow injections (chiefly on the next day) when between and before the temperature is normal, we can with certainty conclude that the patient is tuberculous."



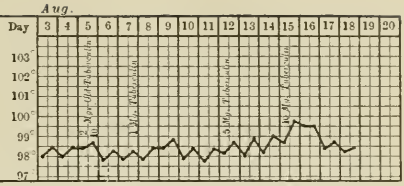
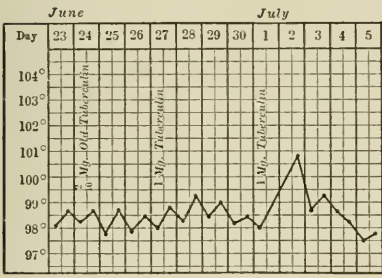


FIG. 78.—TUBERCULIN INJECTION WITH NEGATIVE RESULT. Slight reaction after second injection. No rise after third and fourth. Diagnostically negative.

FIG. 79.—MILD REACTION AFTER FOURTH INJECTION. Local reaction in right lower lobe. Bacilli in sputum during reaction. Diagnosis: Tuberculosis right apex and right lower lobe.



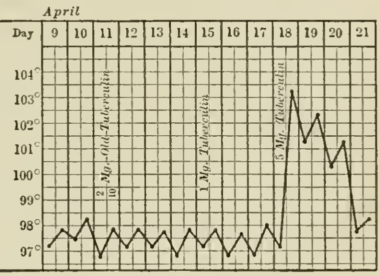
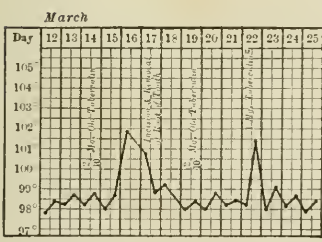


FIG. 80.—MILD REACTION AFTER SECOND INJECTION (1 mg.). Stronger reaction after repetition of same dose.

FIG. 81.—ACTIVE REACTION AFTER THIRD INJECTION (5 mg.). Rapid rise on day of injection. Fall by lysis in course of three days. Diagnosis: Tuberculosis upper right lobe. Local reaction.



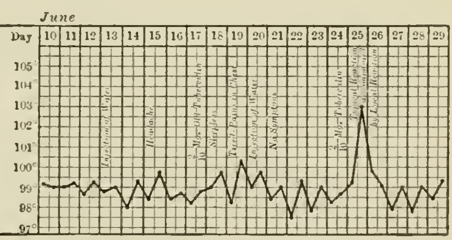


FIG. 82.—AFTER FIRST INJECTION PSEUDO-REACTION FROM PARULIS. After second injection (same dose) no reaction. After third injection (1 mg.) moderate reaction. Tuberculosis of both apices.

FIG. 83.—TUBERCULIN DIAGNOSIS IN NEURASTHENIA. Fluctuating temperature (over 98.6° F.) before injections. Control injection with water; no distinct reaction, normal conditions. After first tuberculin injection mild reaction; on repetition stormy. Local reaction at left apex.

NOTE.—The temperature charts here given are from Bandelier and Roepke ('08), transposed into Fahrenheit degrees.

Contraindications.—However useful this test may be, its indiscriminate use is to be discouraged, and, as already noted, it should only be resorted to when every means of making a diagnosis has been used, and even then it should not be applied unless the case seems strongly suspicious. Further, the temperature must not be higher than 99.2° F. Recent acute diseases in the chest or elsewhere are a contraindication, or any hemorrhages within the month. Heart disease, if the heart be compensated, need not prevent its use, but if uncompensated or of a severe form, it is a contraindication. Nephritis and epilepsy are also regarded as contraindications.

The tuberculin test in itself, and unsupported by anything else, does not justify the diagnosis of a case as clinically tuberculous, as it may be caused by an inactive encapsulated focus, and, as Hamman ('08) has well said, "the tuberculin reaction acquires significance only as a part of the general clinical picture," or, to quote Sokolowski ('06), "Excluding the appearance of bacilli we know no single pathognomonic sign for this disease; our diagnosis must rest upon a consideration of all symptoms, their critical weighing and the exclusion of all those processes which could produce the existing condition in the patient," and this test should be regarded as an addition to, rather than as a substitute for, regular measures, and to be used only when distinctly indicated.

Modifications of the Tuberculin Test.—Among the various causes which have served to delay the general adoption of the tuberculin test is the unfamiliarity of the profession with its technic, which is really very simple. As a consequence, the announcement in 1907 by von Pirquet, Wolff-Eisner, and Calmette of new and simple modifications of this test have awakened very general interest.

Von Pirquet's reaction, better called *the cutaneous reaction*, is produced when the skin is abraded through one or two drops of a twenty-five-per-cent solution of old tuberculin (one part tuberculin, one part five-per-cent carbolic glycerin, two parts normal salt solution), which is left in place for a few moments, and then rubbed off (it has been shown that rubbing of stronger solutions without abrasion is sufficient, Lignière's, '07; Moro, '08). In from twenty-four to forty-eight hours a zone of light pinkish redness, about half an inch in width and accompanied by swelling, appears, and finally a papule forms. These signs disappear in about eight days and leave behind some temporary discoloration of the skin.

The *ophthalmic reaction*, better called the *conjunctival reaction*, which was first observed after the application of stronger solutions (ten per cent) by Wolff-Eisner, was clinically applied and modified by Calmette. It is produced when, in tuberculous subjects, a one-per-cent solution of dry tuberculin (alcohol precipitate) in sterile water is dropped into the

conjunctival sac. In the normal man, according to Calmette, this has no result, or at most a very slight temporary reddening, but in the tuberculous, shortly after the application the patient feels a sense of itching, burning, and smarting in the eye. To quote Calmette's original description ('07):

Five hours after the instillation, at times in three hours, all the tuberculous develop a marked congestion of the palpebral conjunctiva; it becomes bright red and shows a more or less intense edema. The caruncle swells, reddens, and is covered with a slight fibrinous exudate. The vascular injection increases by degrees and is accompanied by lacrymation. At the end of six hours the fibrinous secretion becomes more abundant and collects in filaments in the inferior conjunctival *cul-de-sac*. The maximum intensity of the reaction is between six and ten hours. The patient complains of no pain but only a little discomfort, with a sensation of a slight swelling, and some trouble with vision, in proportion to the degree of exudate. There is no chemosis. The course of the rectal temperature is not sensibly altered. . . . In children at the end of eighteen hours, in adults at the end of twenty-four to thirty-six hours, the phenomena of congestion decrease and finally disappear. In healthy nontuberculous people the instillation of tuberculin is without any result. At most one notes, in from one to three hours afterwards, a slight redness, which disappears quickly and is not accompanied by any fever or lacrymation.

Further use of this method by many physicians has demonstrated that this description is excellent if we refer to mild or moderate reactions, but that severe reactions occur at times which can greatly exceed this picture in intensity. The pain and photophobia can be extreme, and the swelling so intense as to close the eye.

Calmette, in his modification of the test, reduced the maximum dose to one per cent. which it is now recognized should not be passed, as, like the tuberculin test, a sufficiently strong dose can produce reaction in anyone, and the effect of strong doses can be very severe.

Collin, of Berlin ('08), an oculist, has dwelt on the possible dangers to the eye from this test, and calls attention to the necessary uncertainty of the dosage, and other physicians and oculists have reported very severe conjunctivitis, ulcerations, and keratitis, and Serafini ('07) even an abscess.

To avoid possible severe reactions, Comby ('07) recommended the use of 0.5 per cent solution for this reason, and Baldwin ('07) would reduce this to 0.35 per cent for the initial dose.

The instillation is best made in the morning, so that the eye can be examined from time to time during the day for signs of reaction. It is convenient to use a delicate dropper, yielding a small and uni-

form drop. The drop is deposited in the conjunctival sac of one eye and carefully distributed around so as not to be promptly winked out. Briggs has suggested that the rapidity with which the lacrymal duct removes secretion from the eye in some people is so great as possibly to affect the results of the test, and he advises position directed to prevent this, a suggestion which seems to me worthy of consideration. If in one day there is no reaction, instill into the other eye the next stronger solution. A 0.5 per cent solution for the first dose, and 1 per cent for the second dose is best; the writer has not found the 0.35 per cent solution to produce reactions. The use of the other eye for the second dose is important, as, even in normal people, a certain degree of hypersusceptibility is created in the eye by the first dose, and in the tuberculous in the other eye as well, hence a false reaction might occur in the nontuberculous with the second dose if the same eye is used twice. Unlike the tuberculin reaction, there is no effect on the temperature in the large majority of cases, though Wolff ('08) and Cohn ('07) have reported cases where this occurred, and in Cohn's case there was both local and gland reaction and general phenomena. Baldwin ('07) advises classifying the results as: *first*, negative; *second*, doubtful, in which there is slight reddening of the caruncle; *third*, positive +, distinct palpebral edema and secretion; *fourth*, positive + +, ocular and palpebral edema, with well-marked secretion; and *fifth*, positive + + +, deep injection of entire conjunctiva, with edema of lids, photophobia, and secretion.

The contraindications are the presence of any ocular disease, especially conjunctivitis, and more especially what has been called the strumous diathesis. In a patient with this diathesis the writer has seen a very severe reaction, with great discomfort for ten days, pain, great photophobia, lacrymation, severe edema, with swelling of the lid so as to nearly close the eye, and profuse secretion.

The advantages of the method are its simplicity and ease of application, its rapidity, but to my mind especially its applicability in febrile cases where tuberculin is contraindicated, and in children who are frightened by the hypodermic injection. It is too soon as yet to decide on the reliability, utility, and safety of these tests, and in view of the large number of latent, unsuspected cases of tuberculosis, a positive reaction in apparently healthy people cannot be regarded as proving them unreliable. Only time and clinical work can decide the percentage of reliability, which has been reported anywhere from fifty to ninety-eight per cent, the statistics of different authors differing widely. Some, especially French writers, are enthusiastic; some well-known authorities, like Moeller and M. Wolff, have given them up entirely as no more simple and far less reliable than the older method. It seems, however,

probable that the cutaneous method, and even the more generally applicable conjunctival method, cannot be regarded as complete substitutes for subcutaneous injection, but only as an occasional resort in the cases noted.

It would seem that the cutaneous application is chiefly useful negatively and in nurslings under one year, and may possibly prove useful in suggesting the presence of latent foci, while the conjunctival is more useful clinically and in the diagnosis of active trouble (Wolff-Eisner, '08; Engel and Bauer, '07; Warfield, '08). The negative result of a cutaneous test is strong evidence of the absence of tuberculosis, but a positive reaction, save in infants, as noted, cannot safely be made the basis of a diagnosis of active tuberculosis; but it should cause us to reëxamine the case most closely and apply the subcutaneous test. At present the tendency to accept a positive cutaneous reaction as proof of active tuberculosis in adults seems likely to lead to errors in diagnosis. Detre ('08) has suggested the use of the cutaneous test to distinguish between human and bovine infection, using human and bovine filtrates cutaneously in parallel rows. Sixty-nine per cent of his cases reacted to the human inoculation; only four per cent to the bovine; twenty-two per cent to both. This, however, will need further proof.

The specific nature of anaphylactic reactions is made the basis of a diagnostic test in tuberculosis by Yamanouchi ('08) by transferring the fresh blood or serum of the patient to healthy young rabbits (weight, 400–800 gm.). About 5 c.c. of blood are withdrawn from a vein into 2 c.c. of one-per-cent sterile sodium-citrate solution to prevent coagulation. This is injected without delay into the peritoneum of a rabbit, or the same amount of fresh blister serum may be employed.

After twenty-four hours 5 c.c. of a saline extract of tubercle bacilli are injected intravenously. Instead of this, from $\frac{1}{2}$ to 1 c.c. of old tuberculin, diluted to 5 c.c., may be used. If no symptoms of anaphylaxis follow immediately, the same dose is repeated twenty-four hours later, when the sudden death with respiratory failure and convulsions ensues if blood from a tuberculous subject has been used; otherwise, no apparent inconvenience results even after further repetition of the toxin injection.

Yamanouchi details 42 cases of tuberculosis and 12 of other diseases, with uniform success in their differentiation. Baldwin, of Saranac, has been able to confirm the results in 4 cases thus far.

The Agglutinative Serum Reaction.—A few years ago Arloing and Courmont ('05) recommended this reaction as a diagnostic measure in tuberculosis. Homogeneous culture of bacilli are obtained by a special culture method (growth on glycerin peptone bouillon of old cultures which are shaken up to insure even distribution and yield a homogeneous mixture of bacilli). Mixtures of the serum of the suspected case with this culture or with a dead culture which can also be used (Koch and Remberg) in

portions of 1 to 5, 1 to 10, and 1 to 20, are examined at twenty-four-hour intervals, both with the eye, to note the clearing of the serum, and the deposit of small flocculi, if positive, or with the microscope to note the clumping of the bacilli, which should occur with tuberculous sera only.

French authors have been very optimistic about this test, but the workers of other countries have been unable to verify their results. Among others, Kinghorn and Twitchell, in 1906, reported a careful study of the subject, through two years, in which they came to the conclusion that it is not a specific sign of clinical tuberculosis, since healthy and tuberculous sera have practically the same agglutinative properties. They, therefore, conclude that it is of no value, especially for early cases, and this is in accord with the more recent opinions of the students of the subject.

Cytodiagnosis (*Widal*).—This depends on the study of the cellular elements of the serum in tuberculous subjects. This serum is either collected from blisters or from natural collections in the pleura or elsewhere, and is mixed with nine-tenths per cent salt solution, with a two-tenths per cent ammonium oxalate addition to prevent the cells from being caught in the fibrinous deposit. The fluid is then centrifuged and the cells are studied microscopically after spreading and drying in the air, and staining with eosin-methylene blue. Widal believes that the preponderance of lymphocytes speaks for tuberculosis, while a majority of polynuclears of the neutrophile and eosinophile varieties excludes it. Outside of France this method has not won general acceptance.

Opsonic Index.—The attempt to apply Wright's work on opsonins and the opsonic index to the diagnosis of tuberculosis has so far not been as successful as has been its use in therapeutics, and the results obtainable scarcely justify the amount of time and labor necessary for its very elaborate technic. This technic (see Appendix) is only applicable by an expert in the best-equipped laboratories, and with ample assistance, and the claims of its advocates as to its diagnostic value have not been corroborated by the careful work of such observers as Simon, Cole, Potter, Thomas, and others. It is needless, therefore, to enter very fully into the subject in this place, but the principles on which it rests demand some notice, and the claims of its advocates should be stated.

Opsonins are those substances in the blood which so act on the bacteria as to facilitate their phagocytosis. They are normally present in the blood (normal opsonins) and are present in disease (immune opsonins) and are supposed to represent one of the efforts of nature against the infection. The opsonic index is the ratio of phagocytosis in the serum of the blood of the patient to that in the serum of normal blood taken from one or more healthy people. Thus if a hundred leu-

cocytes in serum from a tuberculous case take up 50 bacteria and a similar number in serum from a control take up 100, the index is $\frac{50}{100}$, or 0.5. The normal index is from 0.8 to 1.2, and according to Birkett and Bulloch ('05) is fairly fixed, though Thomas ('07) disputes this.

Diagnostic conclusions are drawn from the amount of phagocytosis as to the presence or absence of tuberculosis. Unfortunately, it is chiefly in advanced cases in which a diagnosis is easy, that positive conclusions are justified, as even its advocates admit (Ross, Birkett).

In tuberculosis we can have five types of indices—normal, high, low, fluctuating, and a heated serum index, and in their study we must consider also the effects of rest, exercise, massage, the existence of other diseases and the injection of tuberculin, and also must compare the index of the blood serum with that of the serum procured from other fluids arising near the focus of trouble.

(*a*) *Normal Index.*—Wright and Reid, according to Potter, claim that with a persistently normal index tuberculosis can be excluded with all probability.

(*b*) *High Index.*—Ross, of Toronto, considers a high index (1.4 or over) on several occasions diagnostic, and Birkett thinks it is a valuable sign that nature is combating the bacillus, and thus that it is evidence of active tuberculosis in the system. Butler Harris says: "A valuable feature of the opsonic method lies in the fact that a new weapon is provided for accurate diagnosis. Wright, Bulloch, Lawson, Urwick, and others have conclusively shown that no normal person ever gives a high index." Bulloch, who is much more conservative in his claims, says: "An abnormally high index is probably a sign of infection, but it cannot be used prognostically, as it may occur in cases which do well and in those which are quite hopeless." Wright and Reid, quoted by Potter, consider a high index proof of a systemic tuberculous infection.

(*c*) *Low Index.*—Harris considers that this occurs in all early cases of tuberculous infection of the lungs, and that such an index is found in cases in which the lesion is shut off almost entirely from the blood stream and little or no bacteria get into the circulation. Bulloch says that from determinations he has made "it appears that an index below 0.8 is abnormal, but whether it actually represents that an infection has already taken place or merely may take place it is impossible to say, as the diagnosis at very early stages of tuberculosis, especially of the lungs, is an impossibility without resort to the tuberculin test. The question whether a low index is the cause or the effect of the infection is unanswerable at the present time." Ross doubts its reliability, but considers an index of 0.6 or lower strongly suggestive of tuberculosis, but not absolute. Birkett thinks a low index has comparatively little value,

as several types of infection give it, such as pneumonia, chorea, and malignancy.

Fluctuating Index.—Birkett considers this suggestive of tuberculosis if the patient be at rest in bed, but only severe, easily diagnosed cases will run such an index while in bed; hence he considers that only when normal in bed and becoming fluctuating by exercise or massage can it be valuable, and he thinks this can occur in quite early cases. Ross considers a persistently fluctuating index very probable evidence of tuberculosis. Harris notes that in doubtful cases where there is no temperature, if frequent readings show a constantly fluctuating index, a little above or below normal alternately, the patient is probably suffering from an early tuberculous infection.

The Heated Serum Reaction.—Heating normal serum to 60° C. deprives it of almost all its opsonic power, but with tuberculous serum, on the contrary, there is a marked gain in opsonic power in comparison to the normal. In this connection Birkett says: "If a patient, therefore, who is obviously reacting from some toxin, as shown by constitutional symptoms, fails to give an opsonic index with heated serum of 2.5 or more, I believe it to be very strong evidence against tuberculosis being the cause of the mischief. . . . But this does not apply so forcibly to cases running an apyrexial course." The cases where a heated-serum reaction is present have, according to Ross, a manifestly toxic nature (pyrexia), in which a diagnosis is usually easy; hence, save to exclude typhoid, it has not much practical value, though in such cases he thinks it as diagnostic as a Widal test.

Serum from a focus of infection, pus, pleuritic, or peritoneal exudate, joint effusion, etc., shows a much lower index than that of the serum from the same patient's blood, and Birkett considers such a difference strongly diagnostic, while similarity of the indices of these two sera, he thinks, suffices to exclude tuberculosis in the process yielding the effusion. However, he says of this method: "Theoretically, the method is ideal, but practically it is disappointing," and adds: "Therefore I place very little reliance on this method as a help to diagnosis," although he holds that a nonfluctuating index, or a similar index for blood serum and pus serum, is very strong evidence against tuberculosis. Da Costa ('07) says that the opsonic index can be helpful in determining cases of tuberculosis by the fact that a drop in the opsonic index caused by an injection of tuberculin is greater and more persistent (a week or so) in tuberculosis than in normal people (two days). As to the diagnostic value of readings of the opsonic index, Ross considers that opsonic investigations of the blood for diagnostic purposes, while valuable for exceptional cases, is not of use in ordinary incipient cases, and considers that the two most important factors are abnormal phagocytosis with

heated serum and fluctuation of the index, whether spontaneous or as a result of exercise, massage, or tuberculin injections. Bulloch ('05) says: "Much more evidence must be accumulated before a definite opinion can be expressed upon this important point."

After such a *résumé* of the views of those most familiar with opsonic technic, it seems to me justifiable to conclude that as yet we have not reached a point in the development of this method where the information it can give us diagnostically is certain enough to demand a resort to so complicated a technic in our diagnostic work.

DIFFERENTIAL DIAGNOSIS

There are various conditions, both pulmonary and systemic, which can closely simulate pulmonary tuberculosis or be simulated by it, and can render the diagnosis, even of an advanced case, difficult.

Of these the one that will most frequently be met with is *bronchopneumonia*, and as pulmonary tuberculosis so commonly manifests itself as a bronchopneumonia, the determination of the real etiology of the trouble may be difficult. This is especially the case when we are dealing with the influenza pneumonias which are so common. Finkler and Wassermann have also drawn attention to the occurrence of streptococcal bronchopneumonias that can be confusing.

In every influenza epidemic one sees some cases which develop into tuberculosis and some which simulate it closely, but finally clear up, leaving an apparently intact lung, justifying the belief that the suspicious signs were due to the influenza, although, of course, it cannot be denied that it may have been an abortive tuberculosis.

While such cases are usually in children, and while West and Brown have both stated that a bronchopneumonia in an adult is presumptively tuberculous, the author has seen cases in adults whose signs were those of tuberculosis and which later cleared up entirely. Lord, of Boston, has reported a number of carefully observed cases of chronic influenza simulating tuberculosis, and it behooves us to keep this possibility always in mind.

In children, after attacks of grip, it is often most difficult to decide whether an apical catarrh is tuberculous or influenzal, the physical signs being identical. The presence of the influenza bacillus is not enough to exclude tuberculosis, and in young children it is usually difficult to get any sputum for examination. Lindsay considers that the signs of bronchopneumonia are usually bilateral, but the author has seen cases in which they were unilateral and whose subsequent course sufficed to exclude tuberculosis. The history in influenza is usually shorter and the symptoms at first more acute, but, as noted, the physical signs are

identical and the temperature curve cannot be relied on, and in grip we can have sweats, hectic and wasting (Fraenkel, Lindsay).

Personally I believe that the course of the trouble, which is relatively short in grip and tends to clear up, while it is protracted and obstinate in tuberculosis and tends to spread, must be our chief reliance, but, as noted above, Lord has seen cases with a prolonged course.

Lobar Pneumonia.—This may at times be tuberculous, but in this case the imperfect resolution, the persistence of temperature, the progressive weakening, and the appearance of bacilli, which in acute tuberculous pneumonia is not long delayed, quickly clear the diagnosis.

However, I have found that in negroes, who so often develop a tuberculous pneumonia with rapid breaking down of the lung and fatal course (acute ulcerous phthisis), not a few cases of ordinary pneumonia will raise our anxiety by their atypical course, absence of distinct crisis and very slow resolution, and will yet finally clear up satisfactorily and permanently, and I have come to expect a slow atypical course in this race.

Chronic pneumonia (*cirrhosis pulmonum*) can very closely simulate fibroid phthisis, and here the history and the persistent absence of bacilli will often be our only guide, though in fibroid phthisis bacilli can be absent for long periods. In such cases only an autopsy will at times serve to clear up the doubt.

Acute bronchitis should rarely give rise to difficulty, but in old people, where it tends to a sluggish course, the distinction may not be easy. The facts on which we have to depend are the absence of dullness, the absence of marked alterations of the respiratory murmur, the fact that bronchitis is commonest in the lower parts of the lung, and if general clears up above sooner than below; the bubbling or sibilant rather than crepitant nature of the râles, the fact that in bronchitis the râles are usually similar on both sides, which is rare in tuberculosis, and that they are disseminated rather than localized, and, finally, the fact that in tuberculosis a sputum so abundant will usually show bacilli. The temperature also in bronchitis is usually only temporary. However, it must be recalled that tuberculosis at times can begin as a generalized bronchitis.

Chronic bronchitis is differentiated in the same way, the history and the sputum examination being especially useful.

Asthma gives rise to diagnostic difficulties chiefly in masking a tuberculous focus, and in doubtful cases it is necessary to wait for a time when the asthmatic signs are absent before we can satisfactorily search for the coexisting tuberculous trouble.

The two conditions have been supposed to be antagonistic, but not a few real asthmatics will be found among our tuberculous cases, not to mention the pseudo-asthma we find in old fibroid cases.

The X-ray is very useful in demonstrating a concealed focus in an asthmatic, and the sputum examination is very important in all doubtful cases, but the presence of the spirals of Curschmann or of Charcot-Leyden crystals in a sputum does not, of course, exclude the existence of tuberculosis.

Pleurisy.—The fact that the large majority of pleurisies have a tuberculous basis is now so well recognized that we are less likely than formerly to overlook a tuberculosis masquerading as a pleurisy with effusion.

In every pleurisy we should study the apices as carefully as the heart in rheumatism, but should not forget that pleurisy can produce transient râles at the apex that cannot be differentiated from fine crepitant râles. While the fluid in a pleurisy rarely shows bacilli microscopically, even when we precipitate with alcohol, it should always be examined, and animal experiments resorted to to determine the possible presence of the germ.

The appearance of the fluid is of some value, as tuberculous fluid is frequently bloody and rarely purulent, but if the possibility of cancer exists, in which bloody fluid is also common, this will not help us.

The fluoroscope I have found of help as revealing sometimes apical shadows and more commonly enlarged bronchial glands.

Bronchiectasis must at times be differentiated from old cases of tuberculosis with cavitation. Here we rely chiefly on the history of a persistent bronchitis without marked constitutional symptoms and with the discharge of large amounts of fetid, stinking sputum at intervals, with intervening periods when but little is brought up.

In some cases of tuberculosis the sputum can at times be offensive, but never has the persistently foul odor of bronchiectasis.

A pronounced case, with its remarkably abundant paroxysmal emptyings of the tubes and a sputum which separates into three layers, is too typical to cause any doubt, while so abundant a sputum in tuberculosis would always show bacilli which here are absent, as are also elastic fibers.

The presence of blood cannot help us, as, while rare, it can occur in bronchiectasis. Fever is often absent, and when present is irregular and intermittent, being usually absent just after the evacuation of the tubes. Bronchiectasis usually affects the lower bronchi and the upper lung is apt to be free, while in tuberculosis, if a cavity exists in the lower lobes, there will practically always be considerable old trouble in the upper part. Tuberculosis, when cavities are present, is also always bilateral, while bronchiectasis is usually unilateral.

Bronchiectatic cavities show up as spindle-shaped, irregular shadows, usually radiating down and out, and it is typical of them that after

evacuation of their contents they nearly or totally disappear from the screen. If, however, as Holzknecht notes, there is much peribronchial thickening, considerable shading may be left, and we may be in doubt whether we are dealing with a cavity in the lung which has emptied or a bronchiectasis. Around tuberculous bronchiectasis there will, of course, be infiltration.

Pneumothorax can be mistaken for a large, smooth-walled cavity, as the latter can yield amphoric breathing, tympanitic resonance, and large resonant râles, but careful physical examination should settle the doubt, while the X-ray gives great assistance in diagnosis. The sudden dyspnea has been taken for asthma, but the cardiac dislocation, the bulging chest, and the percussion and auscultation findings should clear up the question.

Actinomycosis.—This disease can present insuperable difficulties in early primary cases, but, fortunately, primary actinomycosis of the lung is rare (twelve to fifteen per cent of all cases, Fraenkel), and if secondary, the primary lesion in the tongue, jaw, intestines, or liver makes the diagnosis simple, though it must be recollected that the two conditions at times coexist.

In early cases a moderate cough, with scant expectoration and signs of pulmonary catarrh, give no points on which to base a diagnosis, though the central or basal location common in this disease may be suggestive. Even after the first stage the usually very chronic course—the wasting fever and formation of cavities, and the subsequent fibrosis with shrinkage, and the tendency to adhesive or effusive pleurisy—can be strongly suggestive of tuberculosis.

Of course the discovery of the typical organism in the sputum is final, but this may not appear till late, and the absence of bacilli and elastic fibers cannot exclude tuberculosis, save in cases with advanced lesions, where they will scarcely be absent.

On the whole, the history of an occupation which brings one much in contact with grain or hay (coachmen, millers, etc.), the usually lateral basal location of the trouble, the tendency to bulging of the side, the formation of thoracic-wall abscesses and fistulæ, and the pain in the side must be our chief reliance.

The good effect of potassium iodid in many cases cannot be relied on in diagnosis, as it is often without therapeutic effect.

Echinococcus cyst of the lung is not only an exceedingly rare condition, but, practically always, only diagnosticable by the microscope.

When the cyst evacuates itself, shreds of membrane, hooklets, or daughter cysts may be found, and as this evacuation is often accompanied with hemorrhage, these should be looked for in examinations of hemoptysis.

The physical signs are of little assistance. The disease is commonest in the bases and rare in the apices; moreover, there may be localized bulging of the chest wall, and if the cyst be full there will be dullness and weak breath sounds, but no râles.

Fever is absent. Even if a cyst be suspected, puncture for diagnostic purposes is not wise, as such puncture has frequently proven fatal with severe pseudo-asthmatic attacks and edema of the lung (Maydl). It is probable that the X-ray will prove our most reliable means of diagnosis, judging from the cases of Rosenfeld and of Levy Dorn-Zadek. The skiagraph of the latter showed in the right lung a more or less circular clear space surrounded with a dark border, which below was prolonged by a dark band into the dome of the diaphragm, while on the left was a smaller area not so connected. If the cyst were full the shadow would, of course, be solid.

Fungous Infection of the Lung.—Certain fungi, notably the *Aspergillus fumigatus,* the streptothrix, and the cladothrix, as well as certain protozoa, can grow and produce pathological changes in the lung with symptoms suggesting the presence of tuberculosis. The diagnosis can only be made by discovering these various organisms in the sputum.

In doubtful cases, where tubercle bacilli cannot be demonstrated, we should therefore be careful not only to stain for tubercle bacilli but to look for other organisms with special stains (carbol thionin-aqueous saffranin).

Pulmonary Syphilis.—While syphilis can be localized in the lung, the physician should be very careful before he makes such a diagnosis, and the coexistence of syphilis and tuberculosis is too common to justify us in concluding that a pulmonary lesion in a syphilitic patient is syphilitic until we have used every means of excluding the one and diagnosticating the other. While, however, pulmonary syphilis is rare, it occurs in a certain number of syphilitics, Haslund, quoted by West, reporting 2 diagnoses *intra vitam* in 6,000 syphilitics; and in 18 syphilitics dying of the disease, 3 showed pulmonary syphilis. Excluding the white pneumonia of the new-born, which here does not interest us, there are, according to the excellent classification of Sokolowski, three forms of pulmonary syphilis—a focal, a destructive gummatous, and a fibroid—though French authors make numerous classes.

The last of these forms is the more usual, but the first is the most important, as it can simulate early tuberculosis, and its recognition has valuable therapeutic results, while the latter is scarcely to be distinguished from advanced fibroid phthisis, and is therapeutically uninfluenced by the iodids. The focal form can deceive us entirely. There is an area of consolidation and catarrh most commonly around the root of the lung, but at times at the apex. The cough can be moderate,

but at times it is very obstinate and harassing, and while fever can be present, it is usually absent. I had such a case under my care where the signs were typically those of apical tuberculosis, and it had been so diagnosed by an excellent observer, but its failure to respond to treatment and the development of certain throat lesions aroused my suspicions, and reëxamining the history carefully in the absence of the patient's wife I got a frank confession of a syphilis of two years' duration, and the rapidity with which all signs and symptoms cleared up on iodid of potash, and the subsequent perfect health for two years, justified the diagnosis.

In another case there was consolidation between the spine and the angle of the scapula beautifully shown by the fluoroscope, with constant harassing cough, but with very little expectoration and no fever.

This patient had received a test dose of tuberculin from other hands, and was said to have reacted positively.

Here also iodid removed all symptoms rapidly, and for the six months during which I was able to follow the case there was no return, probably justifying the diagnosis of syphilis.

The obstinate cough has been supposed to be a diagnostic sign of pulmonary syphilis, but as it is not different from the cough produced by enlarged bronchial glands, and as these exist often in syphilis, its diagnostic value is doubtful. The therapeutic diagnosis by the use of iodid of potash is very reliable. Not only the symptoms, but, to be certain, all signs must disappear, as otherwise one may have removed the syphilitic element but left behind a coexisting tuberculous lesion.

The destructive form the writer has not seen, and it is said to be very rare, but can go on to cavity formation. The sclerotic form is marked especially by dyspnea, or even pseudo-asthma, but this cannot be considered characteristic, as the same can occur in fibroid phthisis, from which it is impossible to differentiate it. Aside from the dyspnea there are physical signs of fibrosis with bronchostenosis, and, as would be expected from the nature of the lesions, iodids have no effect.

To recapitulate the points on which one can base a diagnosis of pulmonary syphilis, they are the existence of syphilitic infection, laryngeal or pharyngeal lesions, less constitutional symptoms than we would expect in tuberculosis, moderate or no fever, and, chiefly, the therapeutic test of mixed treatment, with subsequent observation of the case. On account of the harmful effect of iodid of potash on tuberculosis one should not resort to it unless suspicions are very strong.

Malignant disease of the lungs, whether carcinoma or the much rarer sarcoma, is fortunately uncommon, few clinicians having seen many cases.

When located in the apices or running a slow course it may be very

difficult of diagnosis, but as the large majority are secondary to malignant growths elsewhere the diagnosis is usually facilitated.

In view of its occurrence secondarily a very careful history and a thorough examination of the body for cancerous growth is necessary.

Aside from this the points demanding attention are as follows. They are apt to be central or basal in location, present a more marked and more rapidly developing exhaustion than tuberculosis, while the wasting, on the contrary, is less pronounced than the signs would seem to justify. The waxy pallor of the cancerous cachexia is suggestive if present, but may be absent till later; the infiltration develops very rapidly, such a rapidity in tuberculosis being accompanied by severe constitutional symptoms, and the dyspnea comes on early and is more marked than in fibroid phthisis.

Pain in the chest is more common and far more severe, while fever is usually absent. The cough is very variable, some authors reporting it hard and obstinate, some moderate, due probably, as in syphilis, to the greater or less involvement of the bronchial glands.

The expectoration is scanty and the currant-jelly expectoration, held by some to be typical, can be entirely absent, though there is a marked tendency to bloody expectoration.

Symptoms of pressure on the veins or lymphatics are common, so that we can have dilated bunches of small veins in the thorax, and in late cases enlarged glands, especially above the clavicle and in the axilla, can be found. Pleuritic effusions are common, but share with tuberculous effusions a tendency to bloodiness. The physical signs are not very characteristic, though Fraenkel thinks that the lack of correspondence between the flatness on percussion (with greatly increased resistance) and the insignificant breath changes—i. e., weakened breathing and few or no râles—is a sign of great value.

If cancer cells are found in the sputum they are, of course, decisive, but this does not often occur. However, as has been said in connection with echinococcus disease and fungous disease, in doubtful cases the sputum examination must be thorough, histologic as well as bacteriologic.

Heart lesions which cause congestion of the lung and hemoptysis, chiefly mitral stenosis, are at times diagnosed as tuberculosis, but a careful and systematic study of our cases should make this mistake impossible.

Malaria is a very common, probably the most common, source of error in diagnoses which exclude tuberculosis erroneously.

Every year one sees many cases which have been treated for longer or shorter periods for malaria when the disease was a more or less incipient tuberculosis, and while in a malarial country where so many cases of irregular fever are seen, and where so many are really atypical

malaria, this is perhaps natural, it is, now that the microscope is available to all and can so easily settle the question, no longer excusable.

Blood examinations must, it need hardly be said, be thorough and frequent, and the recognition of the plasmodium certain and positive before we can afford to treat a slow, irregular, remitting fever as malaria and exclude tuberculosis entirely.

The therapeutic test of quinin, while valuable, must be made with caution, as it will often suppress a tuberculous fever for a time.

Moreover, it should be standard practice in every case of such suspicious fever to examine the sputum and the lungs most carefully and repeatedly, and if necessary one should resort to tuberculin.

Typhoid fever is frequently given in a history as the beginning of a tuberculosis, but it is probable that some of these cases were merely the acute beginning of a case that later took on a more chronic course.

The diagnosis of acute miliary tuberculosis from typhoid fever is one of the most difficult in medicine, and often can only be made at the autopsy, hence in every case of suspected typhoid of slightly atypical course we should take care to exclude this possibility. The Widal reaction is here of great value if past typhoid can be excluded. Auscultation is not of great assistance owing to the frequency of pulmonary signs in typhoid.

The temperature in acute miliary tuberculosis is much more irregular as a rule and may intermit entirely, and tends to marked remissions, the respiration is hurried, the face anxious, and there is an ominous cyanosis. Osler states that "leucocytosis is more common in miliary tuberculosis than in typhoid, in which leucopenia is the rule." The typhoid bacillus can be cultivated from the stools or the blood.

Persistent anemia, or especially chlorosis or neurasthenia or dyspepsia, are so often the initial symptoms of tuberculosis, and so many incipient cases are treated for these diseases, that the possibility of tuberculosis should be kept in mind. Chlorosis is so often accompanied by slight fever and so often precedes tuberculosis that the view of some that it is really a tuberculous condition seems reasonable, and the use of tuberculin justified.

In neurasthenia and dyspepsia the thermometer is valuable, and the all too common custom of explaining away a cough that cannot be stopped as a "stomach cough," and of treating it with anodyne cough mixtures, cannot be too strongly reprobated.

If a cough exists it has some physical cause, which in the large majority of cases can be discovered and removed, and no physician is doing his duty to his patient who fails to make a thorough physical examination into its cause.

ON THE RECOGNITION OF STAGES

If the results of the study of the symptoms and signs of our cases are to be utilized in widening our knowledge of this disease, if the observations of many separated observers are to be correlated into a complete whole, it is essential that we have a system of classification for our cases by stages which shall be used by all physicians in their work. Many such systems have been suggested (Petruschky, Brehmer, Königer, etc.), but that put forward by Turban in the year 1899 has been generally recognized as the best and most practical, and it forms the basis of the classifications in use to-day. In Europe the International Anti-Tuberculosis Association has modified it by adopting part of the scheme of Gerhardt ('01), and in this country the National Association has used it as the basis of their classification, but has modified it by adding to it certain clinical data, while Trudeau has a system of his own in which also he combines anatomical and clinical facts in classifying his cases. It is probable that the system of the International Anti-Tuberculosis Association, more or less modified, will finally be universally adopted, and hence it should be familiar to all workers in this line. While retaining the anatomical basis of Turban's scheme almost entirely, this so-called Turban-Gerhardt scheme modifies it by noting the condition of each lung separately, and makes one or two other slight changes. Kayserling, speaking of it, says that "this is a material improvement, as one thereby gets immediately a plastic image of the case in hand; especially in studying results is it a great advantage that we know of each case—which side of the lung is diseased, and to what degree—for only thus is it possible at a reëxamination to determine if the cure is persisting."

While in Turban's original scheme the first stage was limited to changes of the volume of one lobe or two half lobes, in the new it is limited to changes reaching to the level of the clavicle in front and the spine of the scapula behind, save in cases of unilateral trouble, when the second rib is taken for the lower limit.

Further, in the new classification the presence of considerable cavities places the case in the third stage, and the stage of any cases must be judged by the condition of the most seriously affected lung.

The National Association for the Study and Prevention of Tuberculosis appointed a committee to arrange a classification, of which V. Y. Bowditch and, later, L. Brown were chairmen, and this committee has reported a classification which has been generally adopted in this country, and which, while based on the scheme of Turban, is improved and amplified by the addition of certain clinical data without which they considered his scheme scarcely comprehensive enough.

Below I give the classifications of Turban-Gerhardt, of the National

Association, and of Trudeau in parallel columns for ease of comparison. In looking over these the excellence of Turban's idea is evident, and it is not remarkable that it has been popular, but the clinician in using it will find himself hampered by its failure to take notice of the clinical condition of the case, which is of such paramount importance in classifying it.

The anatomical condition alone cannot by itself give us a complete idea of the state of the case; daily one sees patients with quite extensive signs, who are yet in excellent general condition and with practically no symptoms, while some very severe cases can have very scanty physical signs. Indeed, were we obliged to use only one or the other, I believe we would find that symptoms are usually a safer guide to a patient's condition than signs, and I do not believe that any classification for general use can omit certain clinical data from its plan.

If the physician will use a proper system of classification he will find it an easy matter to divide his cases into three stages, both in the commencement and at the end of treatment, and it is earnestly to be hoped that all physicians in reporting cases in the medical press will be careful to classify them in this way.

Turban-Gerhardt	National Association	Trudeau
I	*I. Incipient (favorable)*	*I. Incipient*
Disease of slight severity, limited to small areas of one lobe, that, for instance, in case of affection of both apices, may not extend beyond the spine of the scapula and the clavicles; in case of affection of one apex, frontal, beyond the second rib.	Slight initial lesion in the form of infiltration, limited to the apex or a small part of one lobe. No tuberculous complications, slight or no constitutional symptoms (particularly including gastritis or intestinal disturbances or rapid loss of weight). Slight or no elevation of temperature or acceleration of pulse at any time during the twenty-four hours, especially if at rest. Expectoration usually small in amount or absent. Tubercle bacilli may be present or absent.	Cases in which both the physical and rational symptoms point to but slight local and constitutional involvement.

Turban-Gerhardt	National Association	Trudeau
II	*II. Moderately Advanced*	*II. Advanced*
Disease of slight severity,[1] more extensive than I, but affecting at most the volume of one lobe; or severe disease,[2] extending at most to the volume of one half lobe.	No marked impairment of function, either local or constitutional. Localized consolidation, moderate in extent, with little or no evidence of destruction of tissue. Or disseminated fibroid deposits. No serious tuberculous complications.	Cases in which the localized disease process is either extensive or in an advanced stage, or where, with a comparatively slight amount of pulmonary involvement, the rational signs point to grave constitutional impairment or to some complication.
III	*III. Far Advanced*	*III. Far Advanced*
All cases extending beyond II, and all such with considerable cavities.	Marked impairment of function, local and constitutional. Localized consolidation, intense or disseminated areas of softening, or serious tuberculous complications.	Cases in which both the rational and physical signs warrant the term.

[1] By disease of slight severity is to be understood: disseminated foci manifested by slight dullness, impure, rough, feeble, vesiculobronchial or bronchovesicular breathing, and fine or medium râles.

[2] By severe disease is to be understood: compact infiltration, recognized by great dullness, very weak bronchovesicular or bronchial breathing with or without râles. Considerable cavities, to be recognized by tympanitic sound, amphoric breathing, and extensive coarse consonating râles, come under Stage III. Pleuritic dullness, if only a few centimeters in extent, is to be left out of account; if it is extensive, pleuritis should be especially mentioned under tuberculous complications.

The stage of the disease is to be indicated for each side separately. The case as a whole is to be classified according to the more diseased side. For example, R II, L I = Stage II.

CONDITION ON ARRIVAL AND ON DISCHARGE

(National Association)

A. On arrival:

1. Extent of Disease. (Put here Turban's scale or Turban-Gerhardt.)
2. How long sick?
3. General condition: (*a*) favorable; (*b*) unfavorable.
4. Digestion: (*b*) unimpaired; (*y*) impaired.
5. Pulse (rate).
6. Temperature: (E.) 101° F. or over; (F.) 99° to 101° F.; (N.) Normal.
7. Bacilli: (+) present; (0) absent.[1]
8. Tuberculous complications.
9. Other complications.
10. Classification of case. (Here put National Association classification.)

B. On discharge:

Progressive. (Unimproved.) All essential symptoms and signs unabated or increased.

Improved. Constitutional symptoms lessened or absent, physical signs improved or unchanged, cough with bacilli usually present.

Arrested. Absence of all constitutional symptoms, expectoration with bacilli absent or not, physical signs stationary or retrograding. This for at least three months.

Apparently cured. All constitutional symptoms with expectoration and bacilli absent for three months, signs of healed lesions.

Cured. Same for two years under ordinary conditions of life.

(Also note A 3 to A 9 inclusive.)

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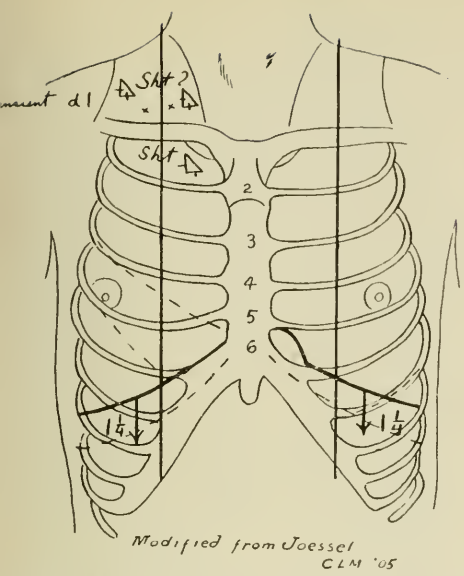
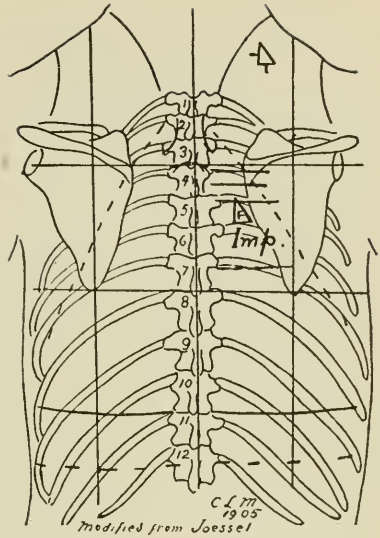
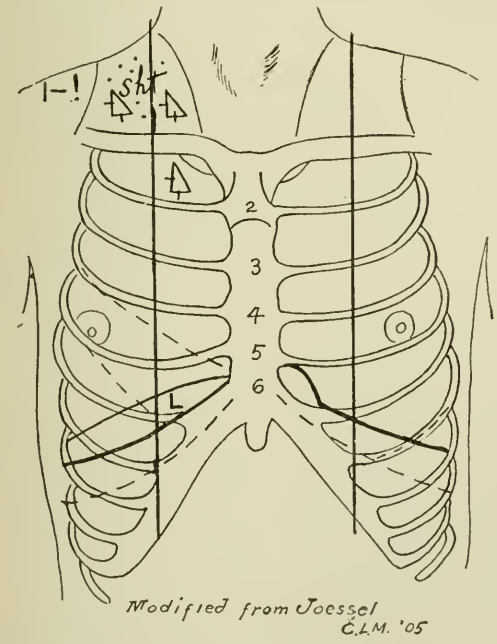
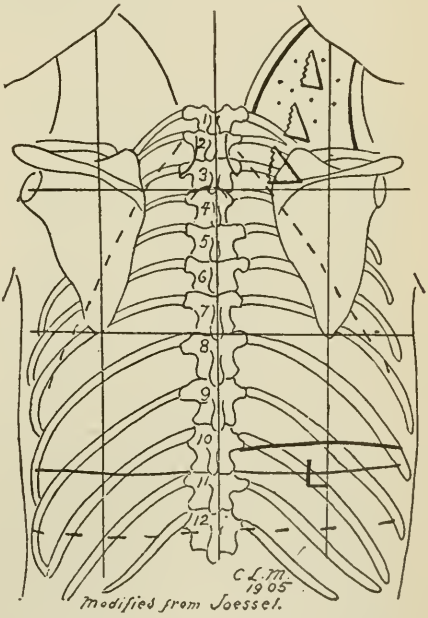
[1] Wilson of Baltimore has well suggested *N*, "no sputum examination made," to cover the large number of cases in which this has been neglected.



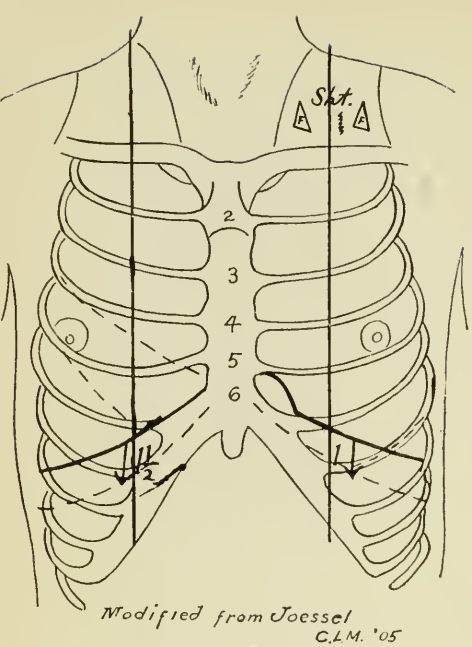


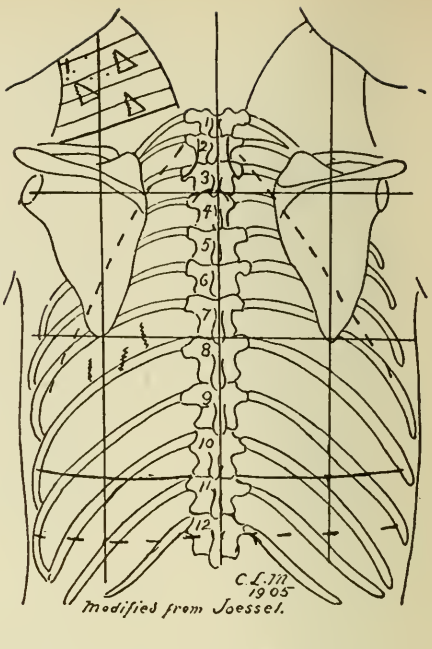
FIGS. 84 and 85.—SUSPECT CASE IN ANEMIC, SLENDER YOUTH. No fever. Slight cough. No expectoration. (Case E. Z.)



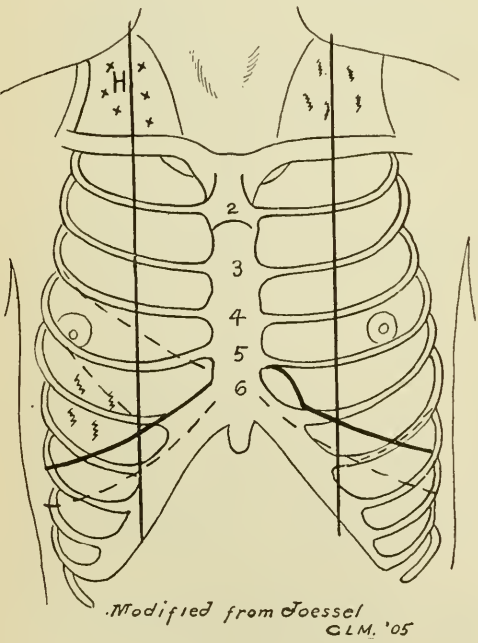


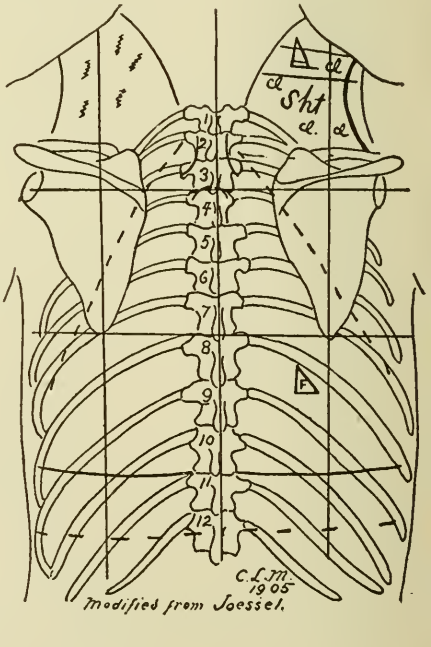
FIGS. 86 and 87.—INCIPIENT CASE. Four months' course. Bacilli present. General condition favorable. Digestion unimpaired. Temperature normal. Pulse 80. (Case C. D.)



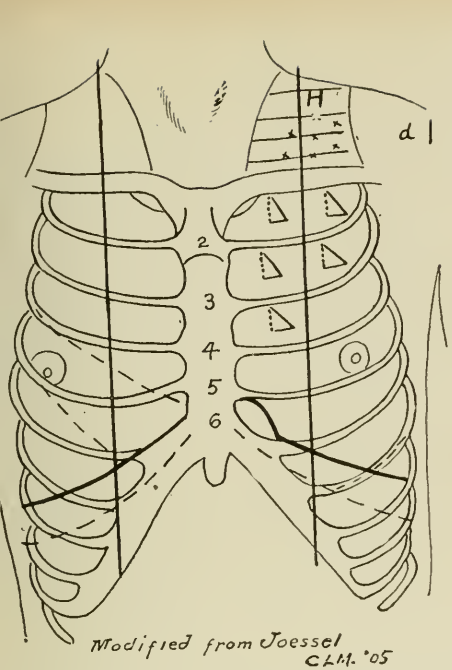


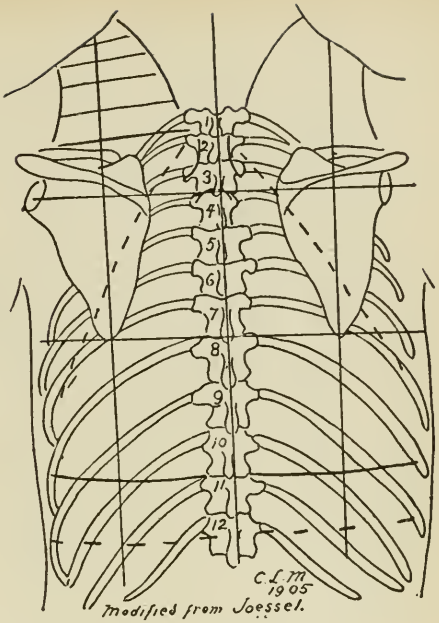
FIGS. 88 and 89.—INCIPIENT CASE, CHIEFLY POSTERIOR, EXTENT I. Note slight pleurisy under left scapula. (Case Y.)



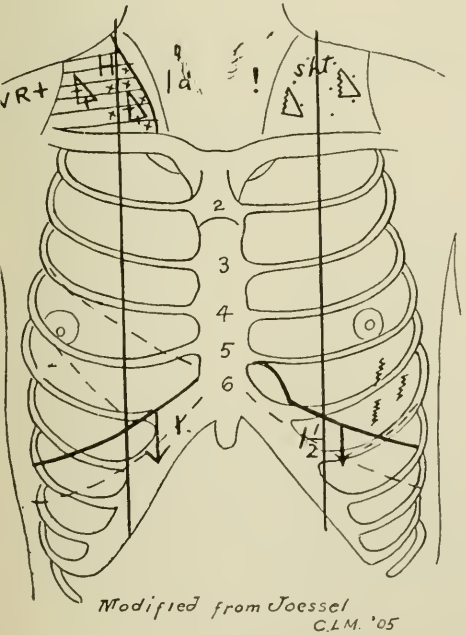


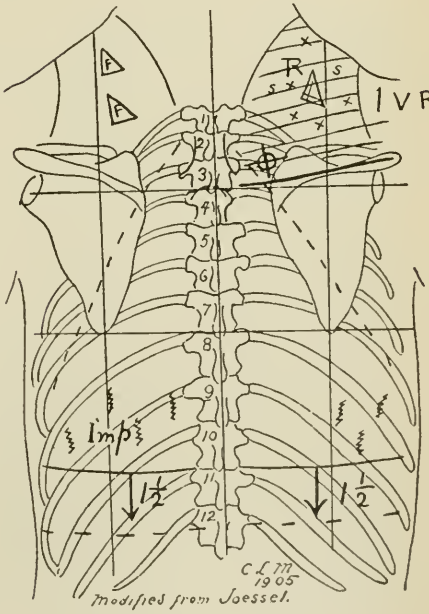
FIGS. 90 and 91.—STAGE I. (Case G. B.)



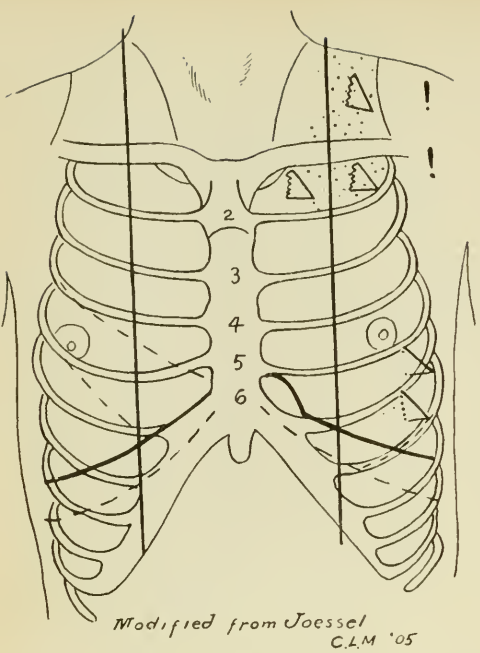


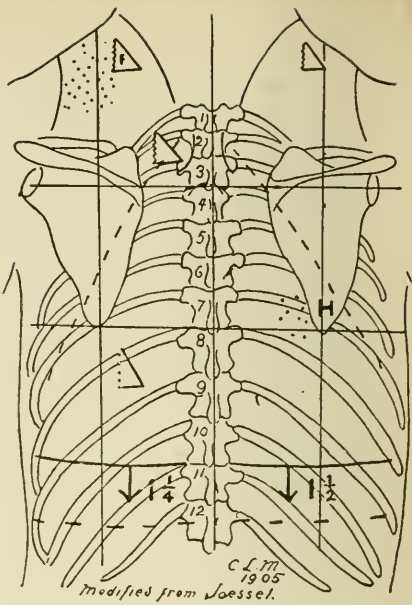
FIGS. 92 and 93.—STAGE I. (Case F. K. S.)



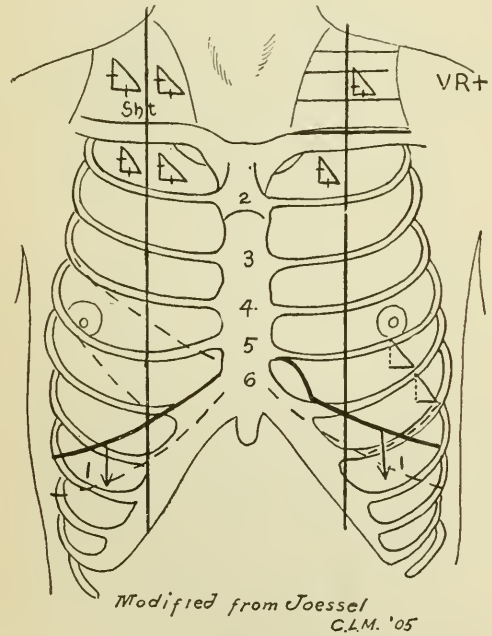


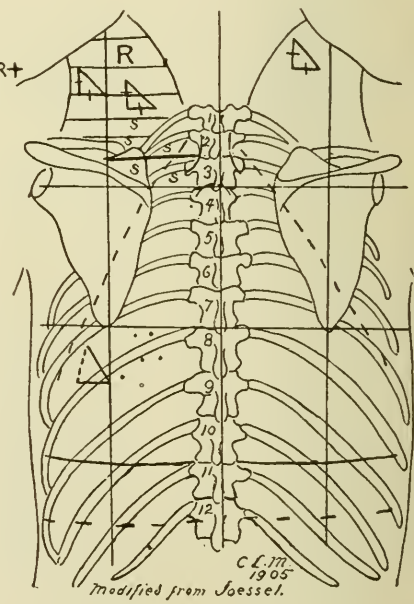
FIGS. 94 and 95.—INCIPIENT BILATERAL CASE. (Case X.)



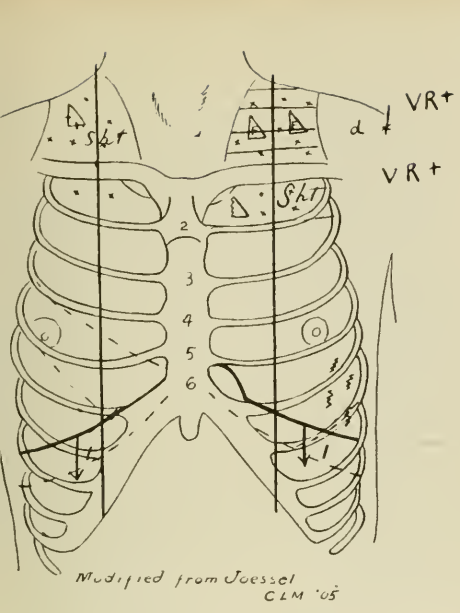


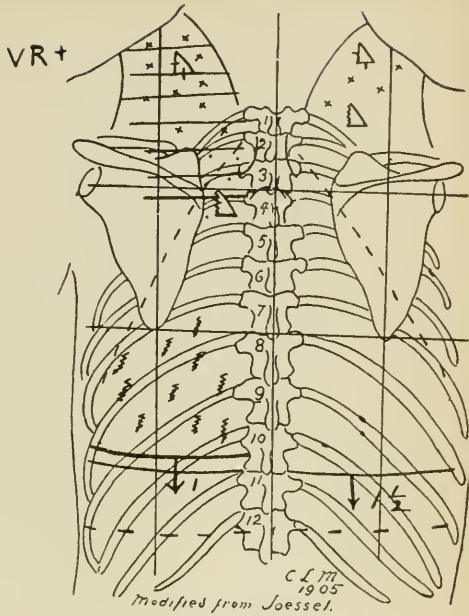
FIGS. 96 and 97.—INCIPIENT CASE, BUT WITH DISSEMINATED LESIONS AND LARYNGEAL INVOLVEMENT. (Case W. B.)



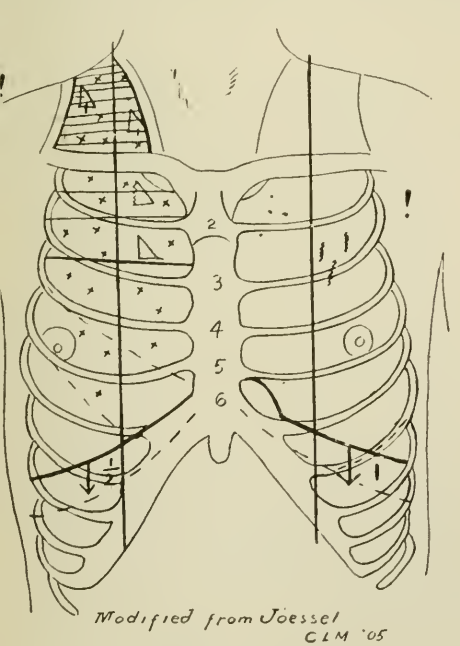


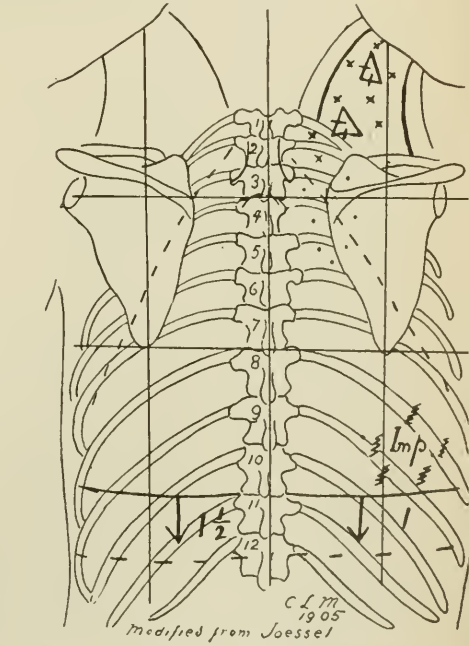
FIGS. 98 and 99.—STAGE II. (Case Mrs. W.)



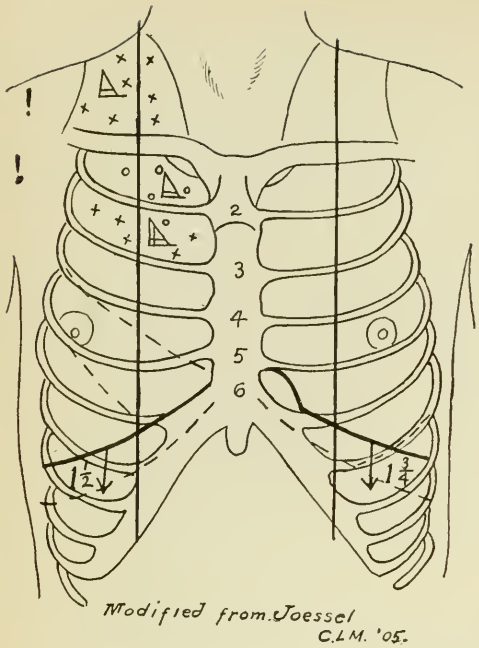


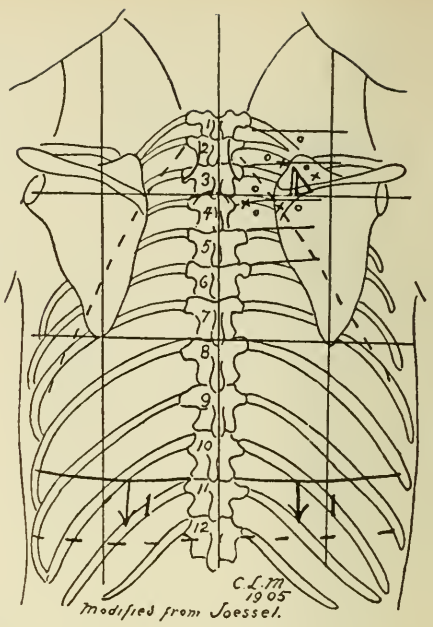
FIGS. 100 and 101.—STAGE II. LEFT BASAL PLEURISY AND LIMITED MOTION. (Case R. S. W.)



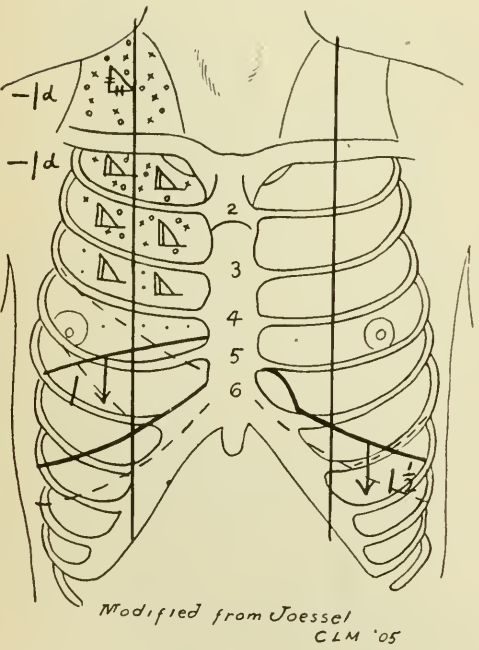


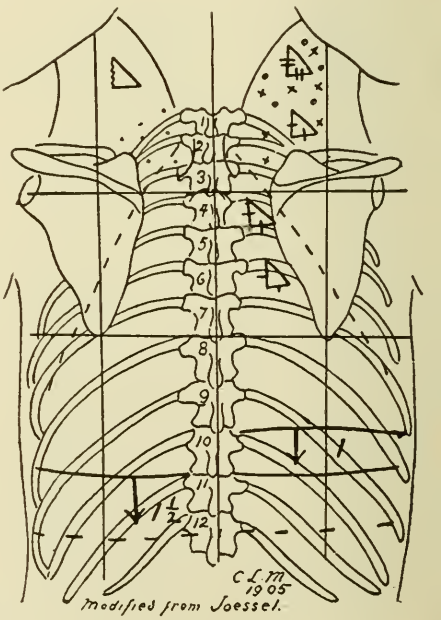
FIGS. 102 and 103.—STAGE II. OF LONG DURATION WITH RETROGRESSIONS AND EXACERBATIONS. (Case J. L. W.)



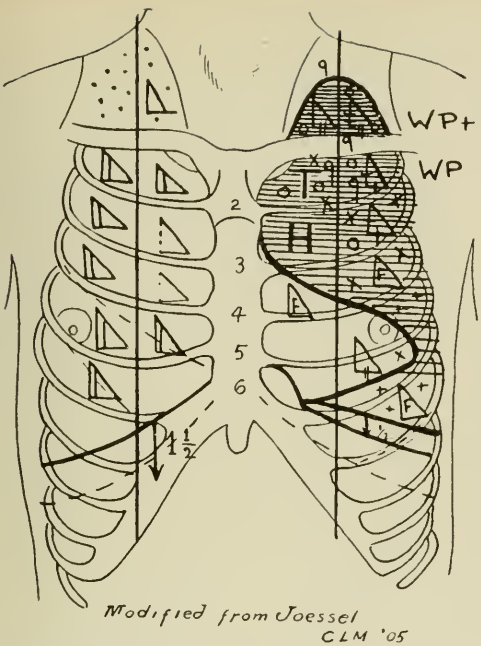


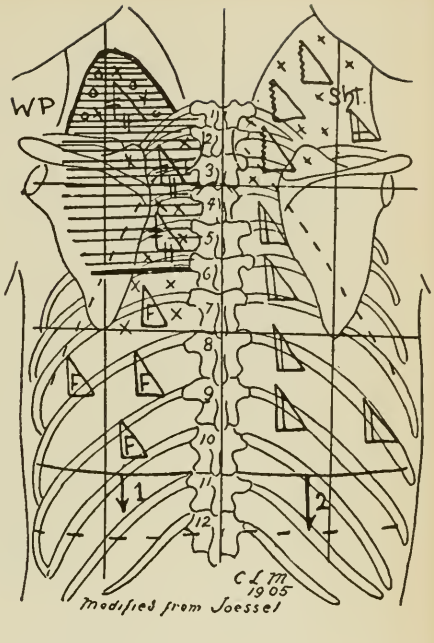
FIGS. 104 and 105.—STAGE II. BEGINNING SOFTENING, LATER EXCAVATION. (Case W. G. B.)



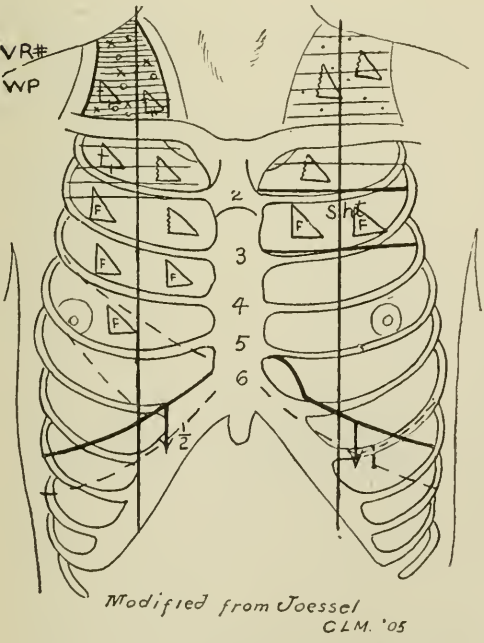


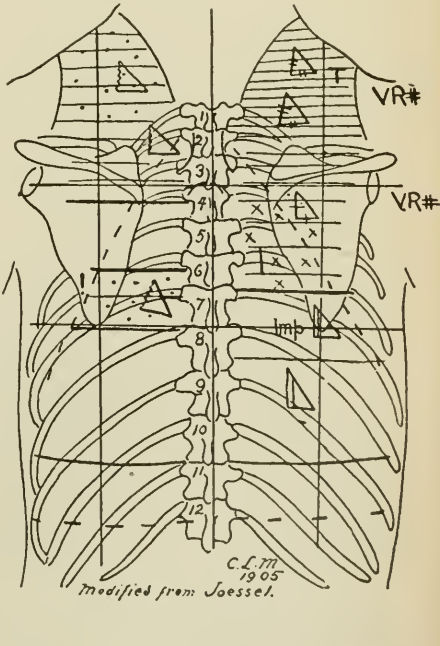
FIGS. 106 and 107.—STAGE II. (POSSIBLY III.), BEGINNING SOFTENING. (Case E. M.)



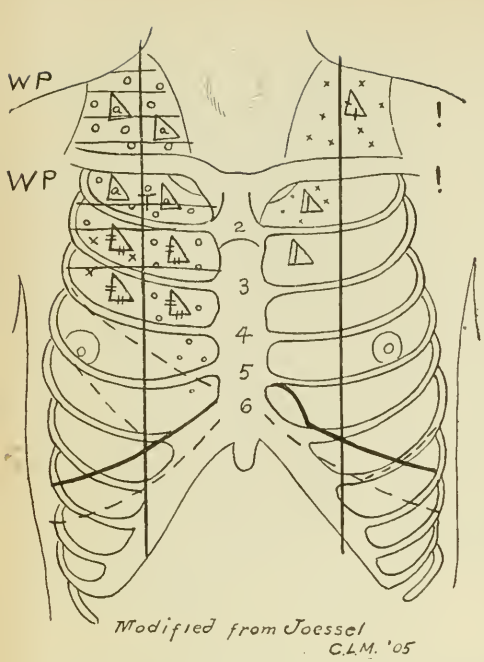


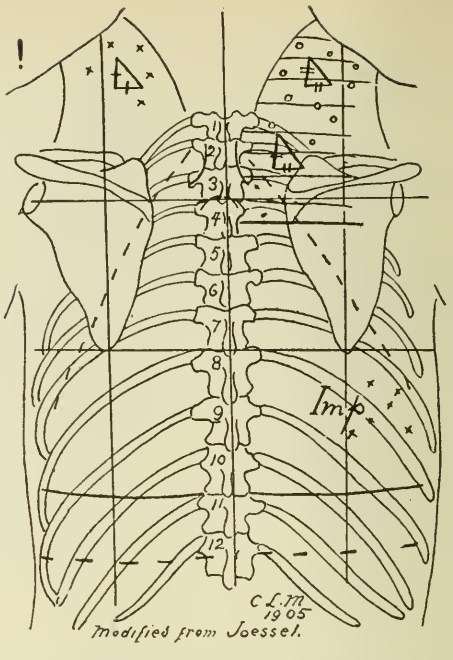
FIGS. 108 and 109.—STAGE III. (LEFT), I. (RIGHT). FIBROID PHTHISIS. Unfavorable condition. Temperature normal. Bacilli present. Note dislocation of heart. (Case R. S.)



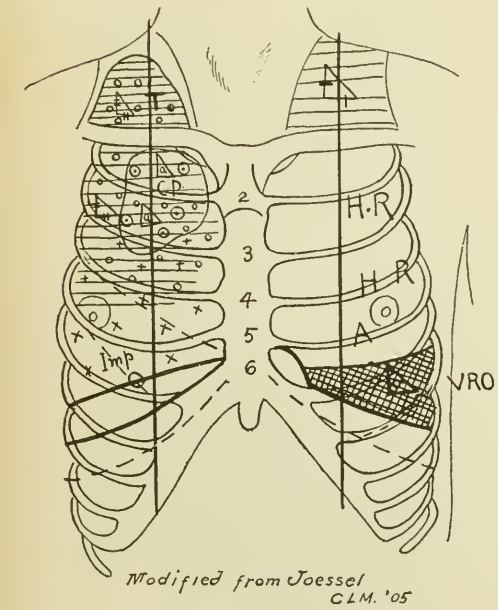


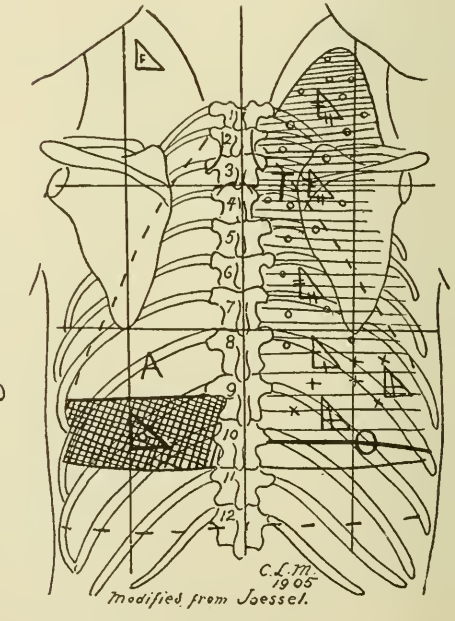
FIGS. 110 and 111.—STAGE III. SOFTENING OF CONSOLIDATED RIGHT APEX. (Case Z.)



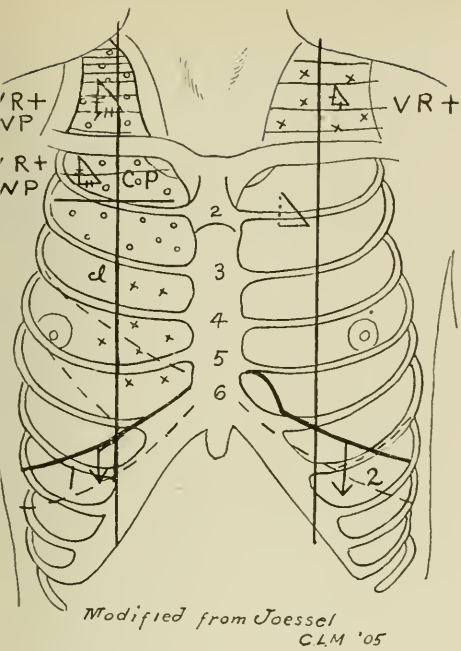


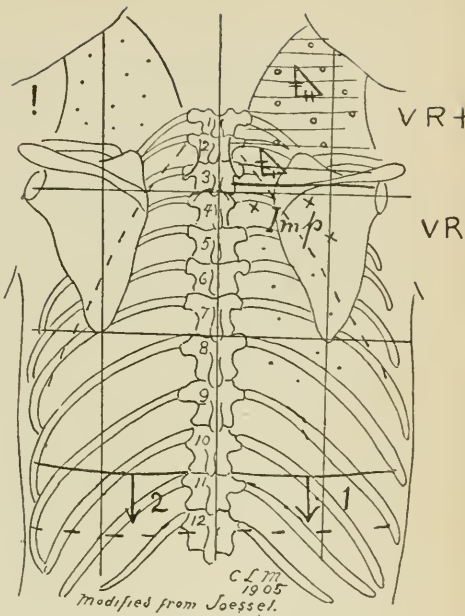
FIGS. 112 and 113.—STAGE III. (R. III., L. I.). CAVITY R. U. A. (Case G. P.)



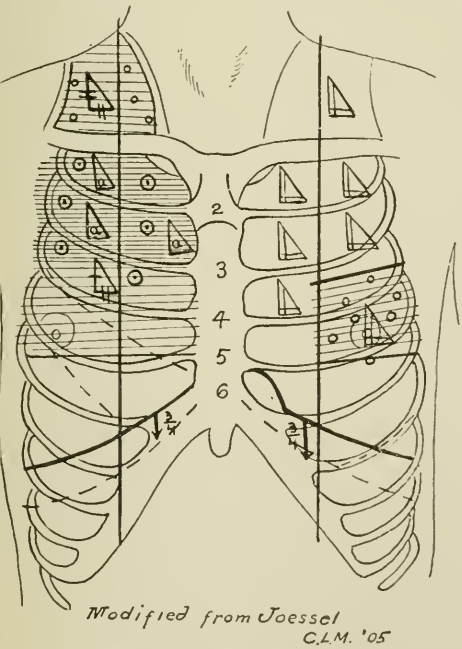


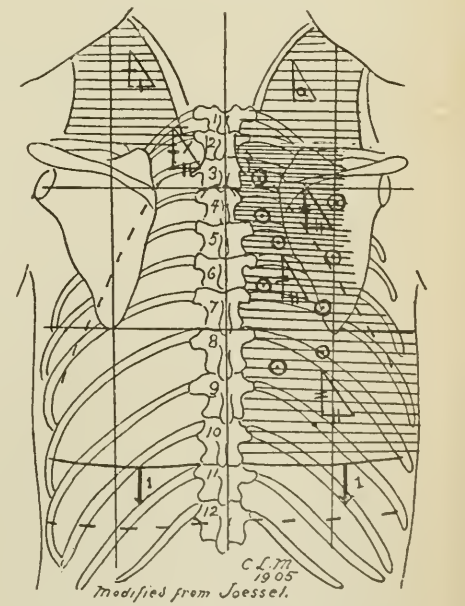
FIGS. 114 and 115.—STAGE III. CAVITY (R) AND FLUID AT BASE (L). (Case C.)



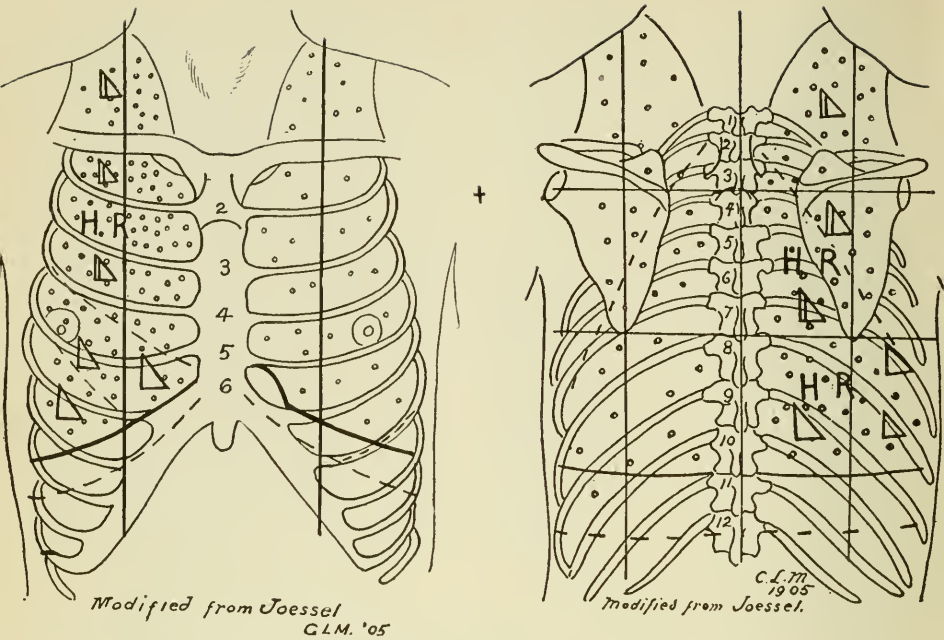


FIGS. 116 and 117.—STAGE III. RAPIDLY SPREADING, SOFTENING. Obstinate fever, reduced by rest. (Case H.)





FIGS. 118 and 119.—ACUTE TUBERCULOUS PNEUMONIA, STAGE III., ILLNESS SIX WEEKS. Hopeless. Note retractions at apices. (Case B. I.)



FIGS. 120 and 121.—ACUTE MILIARY TUBERCULOSIS. Three months' duration. Just before death. (Case Mrs. S.)

ON RECORDING FINDINGS

If we are to classify all our cases carefully it is very important that there should be some uniformity in recording our findings. For this purpose the physician should have good outlines of the anterior and posterior aspects of the chest on which graphically to record the condition of the lung, as well as charts of the mouth, nose, and larynx for recording the condition of these parts. It is better to have these all on one sheet of paper, on the other side of which are spaces for the facts noted on inspection, palpation, and mensuration. Personally I prefer three chest outlines—one for fluoroscopy, one for percussion, and one for auscultation—since this gives ample room; but if, as Trunk advises, we use the pencil for recording percussion and the pen for recording auscultation, both can be recorded on one diagram; but fluoroscopy needs a separate one, on which shadows, limitations of outlines and of motion, etc., can be noted.

The chest diagrams here given I have based on the standard anatomical works of Poirier-Charpy and of Joessel. The upper inner apex outline is better given as concave above and convex below, rather than as in the charts, but any such small details can easily be changed in

any diagrams for which these charts serve as a basis, and from experience I can recommend them as not only correct, but conveniently large, the fault of using too small a diagram, and thus crowding our findings, being one to be avoided.

The facts to be noted under inspection are: General build; nourishment, complexion, and skin; eyes, hair, and nails; teeth, gums, and tongue, dyspnea; glands, heart, stomach, respiratory motion, form of chest—its length, breadth, and depth. Under palpation, vocal fremitus in the different parts of the chest, and the condition and rate of the pulse and the apex beat. Under mensuration should be noticed degree of the temperature, height, weight, and vital capacity, and tape measurements, and there should be a line on each side of which to lay out the lead-tape tracings of the two halves of the chest. There should also be on this chart the condition on arrival and on discharge, according to the scheme of the National Association, as already given. So much for the physical examination chart. Turning to methods of recording the findings, the graphic method is now so generally used that its advantages need not be dwelt upon here. Enough to say that it gives at a glance the condition of the physical signs, enables us to compress much information into a small space and to localize the various signs far more sharply than can be done if we try to describe them in writing. Probably the best-known system of signs is that of Sahli. But desirable as it is that all should use a similar notation if possible, this system has some faults and has been variously modified by different clinicians. Probably every man, whatever plan he follows in the main, will modify it in particulars to suit his own ideas, and the system I have devised, while being both simple and convenient, is given chiefly as a suggestion to others in developing their own systems. It is based in part on that of Sahli, and especially on the excellent plan of Trunk. Whatever signs we use must be capable of being easily and quickly drawn, must be unlikely of confusion with other signs, and must not be too complex. The percussion findings are noted by shadings of various intensity, the limit of dullness being marked by a heavier line, but I have added "Sht." for short percussion note and "Impd." for impaired resonance, neither of which can be indicated by shadings, and both of which are of diagnostic importance.

Under auscultatory signs I have adhered to the rectangle of Sahli, the vertical limb representing inspiration, the horizontal, expiration; but as in hasty drawing it is very easy to miscalculate the length of the base line, and thus to make expiration appear prolonged when it is not, I have added a hypotenuse to the right angle, so that any prolongation beyond the normal is quickly seen and easily indicated. Moreover, since the heaviness of the lines is used to indicate the intensity

of the breath sound by some, the thickness of this hypotenuse can serve as a standard of thickness, and any increase or decrease of the thickness of the other two lines can be noted by comparison with this. The plan of indicating the pitch of the expiratory and inspiratory sounds by the angle made by the lines with the horizontal, which, as far as I know, was first used by Page, has advantages, but cannot be well combined with Sahli's right angle, and as the other is simpler and easier of use I have adopted it. To indicate feeble breathing by light lines is unadvisable, since mistakes can be made in drawing the line, so that I use an F inscribed in the triangle for this purpose as clearer; but to indicate puerile breathing I use a triangle with all three sides very heavily marked, which cannot be mistaken. Absence of breath sounds is very easily indicated by a zero inscribed in the triangle.

Sahli's division of râles is that of Skoda, which is used in Germany, but which has not won acceptance in this country or England, and I have therefore adhered to the plan of dividing râles into dry and moist—as they are given, for example, among others, by Cabot. The part of the respiratory murmur in which the râle occurs can be indicated, if desired, by a vertical line at the side, indicating inspiratory râles, or a horizontal one in the same location to indicate expiratory.

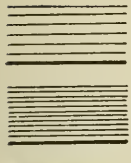
To indicate whether the râle occurs only on deep breath or only after coughing, a *d* or an *!* can be written at the side. To indicate whether the râle is musical (resonant, consonant), a circle (moist râle) with a tail to it, like a musical note, is used by Trunk, with an *m* at the end of the tail if it is metallic.

While one who is not used to employing such signs might suppose them to be complex and troublesome, a short experience of them will convince anyone of their ease of application and convenience, while their import can be understood fully as quickly as the written words.

A good point made by Trunk is the use of pencil to mark percussion findings and of the pen to mark auscultation findings. Pen and pencil are always at hand and are more satisfactory than the red and blue pencils recommended to distinguish percussion findings by Sahli—blue for dullness, red for flatness, with mixtures for intermediate degrees. Preceding the scheme of signs for recording physical findings will be found a few typical charts to exemplify their use, as well as to show the different stages according to the Turban-Gerhardt classification.

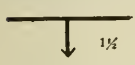
SIGNS FOR RECORDING PHYSICAL FINDINGS

Percussion Signs (to be made in pencil)



Degrees of dullness.
(Note lower or upper limit of dullness by heavier line.)

Flatness.



Motion of base.
(Amount can be noted in inches.)

Motionless base.

Sht. Short note.

Imp. Impaired resonance.

H. R. Hyperresonance.

C. P. "Cracked-pot" resonance.

T Tympany.

Ⓦ Wintrich's change.

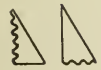
Auscultation Signs (to be made in ink)

Vesicular murmur.

Puerile breathing.

Feeble breathing.

Absent breath sounds.



Rough (granular, "rude").

Prolonged expiration.

Inspiratory, expiratory, inspiratory and expiratory *harsh* breathing.

Cogwheel (interrupted) breathing.

Inspiration interrupted.

Vesiculobronchial.

Bronchovesicular.

Bronchial.

Cavernous.

Amphoric breathing.

H Heart sounds unduly transmitted.

WP Whispered pectoriloquy.

VR + Increased
VR − Decreased
VR o Absent
} Vocal resonance.

A Aegophony.

ADVENTITIOUS SOUNDS

Dry Râles

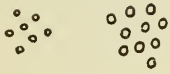
Dry crackles (isolated crepitations).

Crepitant râles.

Medium dry râles.

Large dry râles. Inspiratory. Expiratory.

Moist Râles

 Fine and medium (subcrepitant) râles.

Large moist râles.

Resonant (consonant, musical). Metallic.

Gurgles.

"Mucous click."

s Sibilant râles.

S Sonorous râles.

d Râles on deep breathing only. ! Râles after cough only.

Fine friction sounds. Loud friction sounds.

ADDENDA

Summary of Symptomatology and Diagnosis Presented at the International Congress, held in Washington, D. C.

Landouzy reported on that form of acute tuberculosis first described by himself as "typhobacillose," and which has already been alluded to. He distinguishes it from caseous bronchopneumonia and from acute miliary tuberculosis. No miliary granulations are to be found. There are no localizing symptoms, either pulmonary, cerebrospinal, or abdominal, and, instead of being always rapidly fatal, it usually ends in recovery, so far as the generalized acute infection is concerned. In the majority of cases, after three or four weeks of continuous fever, the patient convalesces, but only imperfectly. Appetite does not return. Emaciation continues, and finally the localizing signs of tuberculosis appear—usually in the lungs or pleura, or, in children, in the mesentery. Occasionally a good convalescence follows such attacks, but, sooner or later, tuberculous lesions appear. Usually, however, after the fever subsides, the patients continue in a state of latent tuberculosis, and in a few weeks, months, or even years after the initial acute septicemia they are found to be tuberculous. He would distinguish it from typhoid fever by the irregularity of the fever curve, which, while continuous, shows greater oscillations; secondly, by a lack of correspondence between the pulse and the temperature—the pulse being faster than in typhoid fever; thirdly, by an absence of visceral symptoms; and, lastly, by absence of rose spots. Its diagnosis from typhoid, as which it usually masquerades, can only be made by the use of laboratory methods, such as the Widal test.

Symptoms.—Von Unterberger does not consider a small heart as predisposing to tuberculosis, but believes that the rapid enlargement of this organ in phthisis is related to a congenital predisposition and is caused by an obstruction to the lesser circulation and by the toxins of the bacillus and of the products of metabolism. He believes that an enlarged heart and liver form a very important link in the chain of early clinical symptoms.

Ullom, as a result of the study of the livers of those dying from tuberculosis in the Phipps Institute, notes that miliary tubercles are found in a majority of cases of chronic phthisis. Solitary tubercles were rare, while passive congestion was found in nearly every case, but amyloid and fatty changes were found in a relatively small number. He does not believe, as the result of his observations, that fibrosis or cirrhosis, due to the bacillus, occurs.

J. Anders, in a paper on the symptomatic value of hemoptysis in

early tuberculosis, notes that cases of hemorrhage in which all other clinical and laboratory findings are negative are to be regarded as tuberculous until disproven. It is, however, not pathognomonic, but, nevertheless, of exceptional diagnostic importance as a cardinal symptom. In 3,506 cases of tuberculosis, 9.6 per cent hemoptysis was noted at the very commencement of the disease, and in cases of chronic pulmonary tuberculosis hemorrhage was one of the most characteristic symptoms in 25 per cent. H. von Schrötter (Vienna) reported on the occurrence of usually undiagnosticated pneumothorax without exudate in early tuberculosis. This can best be studied by the use of the X-ray and the spirometer. A deficiency in vital capacity of 1,000 to 1,500 c.c., especially in a case whose normal vital capacity is already known, permits, he believes, a diagnosis of latent pneumothorax, even if other signs are doubtful.

Tiery and Renoux found that the scales of pityriasis versicolor inoculated into guinea pigs caused tuberculosis, while the scales taken from healthy skin of consumptives or from other dermatoses failed to do so. This, if verified, would suggest that this skin disease is specifically tuberculous.

Metabolism.—Croftan spoke of the increased urinary calcium excretion in tuberculosis. This he would explain by an affinity between the calcium and an albumose which is almost universally present in tuberculous foci, sputum, culture media, blood, and urine. When rendered calcium-free it has marked fever-producing qualities which it loses when again combined with calcium. The combination he regards as a protective antipyretic process which would suggest therapeutic possibilities.

Diagnosis.—The ophthalmic reaction (Wolff-Eisner, Calmette) was the subject of valuable reports by Calmette, Wolff-Eisner, Baldwin, Malmström, Bailliart, and by F. Arloing. None of these observers consider the test dangerous to the healthy nontuberculous eye, and it is probable that the bad results which have been reported (see text) were due to its use in tuberculous eyes. Calmette, in 6,603 cases, had no serious results, and only 3 of phlyctenular keratitis, 20 of conjunctivitis, and 72 slow, persisting reactions. Wolff-Eisner considers it absolutely without danger if contraindications are observed. Baldwin thinks that, used with proper precautions, the danger is slight, and Arloing, Jr., notes that its possible bad effects can be largely obviated by a preliminary instillation of adrenalin, 1 : 3,000.

Diagnostic Value.—The percentage of positive reactions in active tuberculosis was placed by the various writers and speakers at from 70 to 96 per cent. Trimescu placed it at 96 per cent. Calmette, in 2,894 cases, at 92 per cent. Wolff-Eisner stated that 85 per cent will react; Malmström, 86 per cent; and Baldwin, from a study of 310 cases,

70 per cent. White and McCampbell reported on its use in cattle, and note that, since repeated instillations create a hypersensibility, the result of the first instillation alone should be made the basis of diagnosis. They consider that a proper reaction in ten or twelve hours demonstrates tuberculosis. The views as to its diagnostic reliability varied. Wolff-Eisner held that it will be positive only in the presence of active tuberculosis, and Calmette stated that a positive reaction to the ophthalmic and cutaneous tests furnishes almost conclusive evidence of the existence of an active tuberculous focus. He found early reactions chiefly in suspected tuberculosis, late or slight ones chiefly in well-developed tuberculosis, and he, like all others, has found that advanced cases react slightly or not at all. He says that, unlike the cutaneous reaction, it seems to be found chiefly in active or developing foci, and not with healed lesions, and believes that, used in children over one year of age, it shows active tuberculosis. Baldwin considers that the test has some value in confirming the diagnosis in its early stages, but slight value when the symptoms justify only a suspicion. Its value in distinguishing active latent from healed tuberculosis he regards as undecided. He would confine its use to adults, since the cutaneous test is equally valuable for children, and would restrict the subcutaneous test to cases where a focal reaction is desired and where the ophthalmic and cutaneous tests have been negative. Malmström considers it diagnostic and useful, but not final; while F. Arloing regards it as a convenient diagnostic measure whose value is not absolute.

Prognostic Value.—Here, again, views vary. Baldwin regards the ophthalmic as unreliable for this purpose, while Wolff-Eisner considers its prognostic value to be very great and thinks that the failure of the cutaneous and conjunctival reactions is prognostically unfavorable, as is also a rapid (twenty-four hours in all) reaction, while a permanent reaction (seven to twenty days) he considers favorable and occurring chiefly in healed tuberculosis. Calmette thinks that as bad cases react slowly (forty-eight hours), weakly, or not at all, and light ones strongly, the test has prognostic value. However, he calls attention to the fact that since, after five days, hypersusceptibility (anaphylaxis) is established, which lasts for twenty-five or thirty days, we should repeat the test before the fifth day. He also notes that cases taking tuberculin do not react until one month after the injections are stopped. Trimescu (Bukarest) made the interesting statement that while, as is well known, severe cases are generally negative, they can become positive if the process improves and gets less active. F. Arloing reported that he had found that the reaction is caused not only by the presence of tubercle toxins, but also by those of typhoid, diphtheria, and staphylococcic and streptococcic infections. This he ascribes to the vasodilator effect of

these toxins on the vasomotor centers, and considers that it shows a state of intoxication of some sort, but not necessarily tuberculous. The reaction in tuberculosis, in his opinion, shows that the organism is intoxicated by tuberculin, and he considers that the intensity of the reaction indicates the degree of immunity of the individual, and hence is prognostically valuable. As to the physiology of the test, Calmette considers the reaction to be due to the fixation of the tuberculin by the cells rich in lecithin and to the reaction between the two. He believes that the presence of free lecithin in the blood has a close relation to tuberculosis, as the suprarenals are always congested in animals killed by tuberculin, while animals refractory to tuberculin have no free lecithin in their blood. Finally, he very wisely notes that these tests must not be overvalued, but that all other clinical and laboratory methods must be cautiously and wisely used.

The Cutaneous Reaction.—Von Pirquet believes that from a positive reaction the presence of tuberculosis can be concluded. The reaction, however, does not prove that the patient is sick—i. e., has active tuberculosis—but possibly only latent trouble, *and he warns against treating a patient for active tuberculosis on the strength of reaction to his test.* It occurs chiefly in slight or inactive tuberculosis, and in Vienna most grown children and adults react. He believes, therefore, that in adults only a severe reaction on the first attempt has any significance, and that in this case it speaks for a new process. Repeated failure to react, in his opinion, excludes tuberculosis. Its chief value, he believes, lies in children from one to five years of age. Calmette considers it chiefly valuable in cases of calcified and healed lesions and in children under one year of age, of whom about twenty per cent react. After this age the number reacting increases rapidly, and over fifteen becomes sixty per cent, while nearly all adults react, so that he would limit its use to children under one year. A positive reaction to both ophthalmic and cutaneous tests he considers almost conclusive evidence of an active tuberculous focus. LeFetra considers a positive skin reaction in infants almost certain evidence of tuberculosis, and if a careful sputum examination and skin test are both negative, he thinks we can feel safe in ruling out tuberculosis. Detre, of Budapest, read a paper on his method of differential bovine and human cutaneous tests, with old tuberculin and with bouillon filtrate of human and another of bovine bacilli. He reports that ninety-five per cent of all tuberculous cases react to the human test and that most pulmonary cases are of this class, while in children and in visceral and bone tuberculosis thirty to forty-five per cent react to the bovine, while a good number react to both. He advises testing the immunity of a case after treatment by a large dose of tuberculin, after a cutaneous test, when he be-

lieves that if the case be not immune the cutaneous reaction will reappear.

A new modification of the tuberculin test was advocated by Mantoux (Cannes) which consists of an intradermic injection of tuberculin, the needle being introduced only into the derma as in cocainization. The reaction consists of a macula surrounded by a bluish zone, and he considers his modification universally reliable in active tuberculosis. The percutaneous or inunction method of Moro and Lignières was a subject of a paper by the latter, but nothing new was brought out.

L. Brown reported on the diagnostic value of the ophthalmic, cutaneous, and subcutaneous tests. He believes the cutaneous method has no contraindications, but regards the conjunctival test as offering enough risk of severe injury to the eye to cause him to be opposed to the use of the method. As to the subcutaneous, he has "used it in a large number of cases for eight years" and has "yet to see as a consequence anything more than a slight temporary untoward result." He advocates a procedure in the use of these tests which merits general acceptance. "When we wish to apply the tuberculin test to a patient presenting suspicious symptoms or physical signs of tuberculosis," he advises, "first to use the cutaneous test, and if he fail to react with this, we can with some degree of certainty attribute his symptoms to some other disease. If he reacts we can then use either the conjunctival, when no contraindications exist, or the subcutaneous method," in which he places still greater confidence. He feels "that the conjunctival test, like the subcutaneous test, should be used only when all other means of diagnosis have been exhausted." Further, he notes that he hesitates to say "that a patient does not react to the tuberculin test until the subcutaneous test has been found negative." He believes that the cutaneous test reveals very accurately both active and latent tuberculosis, but, since the recognition of the presence of inactive and encapsulated foci has little clinical significance, the cutaneous test alone to him seems to possess slight practical value. Hamman concludes as to the use of tuberculin for diagnosis that the test must be used with care and that while the reaction is believed to be specific, it must be remembered that a very insignificant lesion may produce tuberculin hypersensitiveness. A negative reaction he considers decisive information, as also a focal reaction.

After a consideration of all these different views, it is evident that the conjunctival and cutaneous tests can be regarded as valuable and safe[1] additions to our diagnostic measures and as fully justifiable pro-

[1] P. Schrumpf ('08) concludes, against Teichmann and others, that the ophthalmo reaction can lead to permanent and serious lesions of the eye in spite of all measures of precaution.—Editor.

cedures in properly selected cases. They may at times render unnecessary a resort to the rather more severe subcutaneous method, but which at present they do not seem entirely to supplant.

The diagnostic value of the opsonic index also received consideration. Inman uses the test to demonstrate autoinoculation, either spontaneous or artificial (after exercise), by a variation in the opsonic index which does not occur in the nontuberculous. He notes that the tuberculous patient who exercises is elaborating his own tuberculin. A rise of temperature goes with a negative opsonic phase, showing autoinoculation, and can be checked by absolute rest. Absence of variation after hard labor he regards as evidence of arrest, but some of these cases still show bacilli; hence he believes he is justified in assuming that we can have arrest of the disease but persistence of the bacilli. Sanborn holds similar views about the diagnostic value of the opsonic index. Szabòky considers the height of the index of no value, but thinks that lowering of the index shows the presence of tuberculosis. He believes that it gives an approximate idea of the degree of immunity, and hence is a good guide for treatment. He finds it, however, troublesome and not giving uniform results, the personality of the observer having a great effect on the counts. M. Lincoln considers that the great skill needed for its application limits its utility. She finds that eighty per cent of her ophthalmic and cutaneous tests agree with the opsonic test. The opsonic index was positive in seventy-seven per cent of the cases, while the tuberculin test was positive in eighty per cent of the same cases.

Other Diagnostic Methods.—Cade advocates the study of the cytology of effusions (Widal) for diagnostic purposes, in determining the nature of a pleurisy, predominance of lymphocytes speaking strongly for tuberculosis. In other than pleural effusions its value is doubtful except in ascites, where the discovery of a lymphocytosis is suggestive. Caution and control by other methods, however, is desirable. Sondern has examined the cerebrospinal fluid in tuberculous meningitis in children. He considers a high pressure of the fluid and a high number of lymphocytes (eighty-six per cent) suggestive. If bacilli are present a relative polynuclear increase may indicate a mixed infection, while if bacilli are absent a predominance of lymphocytes should encourage further search. M. Solis-Cohen has studied the coagulability of the blood. Persons with increased coagulability are probably less liable, and those with a decreased coagulability more liable, to hemorrhage. In cases with hemorrhage the bleeding ceased more quickly in those with a short or normal clotting time than in those in whom it was delayed. Bezançon and de Jong have studied the behavior of the cells in the sputum of caseous tuberculous pneumonia, and believe that a tendency to degeneration of the cells (polynuclear and young pulmonary epi-

thelial cells usually mononuclear) is the most marked characteristic of tuberculous lesions, and is especially marked in galloping consumption. They found pycnosis of the polynuclear cells and loss of staining quality.

Arneth's method of studying the nuclei of the polynuclear neutrophiles was the subject of a paper by Dluski and Rozpedzikowski. They examined 55 cases and found in all but 2 a more or less marked impairment of the blood picture, with displacement to the left up to 75 per cent. In 17 of 21 cases examined several times they found agreement between the picture and the course of the disease. They conclude that the method may do good service in the clinical study of the disease along with other methods. Bushnell reports on his use of this method, which he believes to be of distinct prognostic value. He regards it as especially useful in deciding how long it is necessary to keep the patient quiet. "An objective proof that a toxic absorption is present in a degree which constitutes a tax on the resistance of the afebrile patient is one of the great desiderata in the treatment of pulmonary tuberculosis. Arneth, it appears to me, has furnished the means of securing such proof in his method of studying the neutrophylic leucocytes."

Sputum Examination.—Much calls attention to the fact that parts of tuberculous nodules in the lungs of cattle, in which the microscope shows no acid-fast bacilli, produce on inoculation into guinea pigs typical tuberculosis, from which cultures can be made. Cold abscesses in human beings where no bacilli can be demonstrated by Ziehl's stain, give cultures by the inoculation method, and by a modified Gram stain the bacilli can be made visible here as well as in the tissues. The more virulent forms of bacilli he finds most easily decolorized by the acid. The importance of this, if it be verified, need scarcely be dwelt on.

Physical Diagnostic Measures.—Few new procedures in this line were brought forward. Kuthy noted the frequency of thoracic pain of pleural origin, which he found present in 60 per cent of 650 cases, and in 85 per cent of these it was on the side of the most extensive lesion. Seeking for an objective evidence of this pain, he found it in the "clavicular symptom," as he calls it—i. e., the drooping of the outer end of the clavicle, which Aufrecht has specially dwelt upon. But while present in 80 per cent of the first-stage cases, 63 per cent of these had the droop on the most affected side, and in 20.5 per cent of all cases the droop did not correspond to the affected side. The lessened rise or immobility of the acromion on the affected side he calls the "acromial phenomenon," which he found even in the earliest cases; 80.4 per cent of his cases showed it about as often as the "clavicular symptom," but in only 2 of 86 cases did it not correspond with the side of the lesion. He concludes that pleural pain or the "cla-

vicular symptom" indicates the diseased side with about 80 per cent of probability, while the "acromial phenomenon" does this with almost complete certainty. Francke believes that a pain on pressure in incipient tuberculosis to be found where the inflammation is first located—i. e., in the posterior superior aspect of the apices, without relation to respiration—has diagnostic value. He lays stress only upon pain produced by pressure with the fingers or by tapping with the percussion hammer. This early determination of a pleurisy accompanying incipient tuberculosis he calls "algeoscopy." The pain also varies directly with the extent, advance, or retrogression of the trouble, its depth from the surface, and its cure. In 77.5 per cent of 200 cases he found this pain. Of these 154 were light, 32 medium, and 14 severe cases. Waller, in a paper on the methods of percussion, dwells on the great difficulty, when both sides are affected, of correctly valuing the percussion findings. He divides percussion sounds into several varieties, too elaborate to be here reproduced, disapproves of the customary symmetrical comparative percussion, and advises beginning percussion in regions where normally there is a clear, full percussion note—i. e., in front, in the infraclavicular fossæ and behind in the region of the angle of the scapula.

Use of X-rays.—Valuable papers by Williams, Krause, and Rist were read. The former stated, in agreement with his past attitude, that "X-ray examinations, while not infallible, add to our knowledge of conditions present in the thorax, and give fuller, more accurate, or earlier information than the older methods." Krause noted that, "in the main, X-ray diagnosis merely confirms and completes the clinical findings and is limited to the detection of differences in density in the lung," a conservative view. He considers that infiltration which cannot be determined by percussion can often be demonstrated by the radiogram, but that a simple catarrhal process in the early stage cannot be demonstrated either by the fluoroscope or by radiography. Later the apices appear dark and do not clear up during inspiration. He considers that Williams's sign has no diagnostic value. He also dwells on the extreme value of the X-ray in the diagnosis of bronchial-gland enlargements in children. Rist very wisely emphasized the importance of a thorough familiarity by the physician making the X-ray examination, with the refinements of clinical methods of diagnosis of tuberculosis, and noted that if clinical diagnostic work is to be in the hands of one man and the X-ray work in the hands of another, serious mistakes are apt to occur.

Prognosis.—Casselberry emphasizes the fact that the prognosis of laryngeal tuberculosis is better than is generally supposed, and that tuberculous hyperplasia can resolve and tuberculous ulcers will occa-

sionally heal in cases showing a good resistance to the disease generally.

Craig studied the prognosis in children. This he believes is best estimated first by the amount of lung involvement, next by the pulse-rate, and last by the respiration rate. Older children show slightly better results than younger, and those treated in sanatoria better results than those treated in dispensaries or hospitals. The results in children if the disease were not extensive were better than in adults, but when it was advanced they were not so good.

PART IV

PROPHYLAXIS OF TUBERCULOSIS

INTRODUCTION

By HERMANN M. BIGGS

Questions relating to prophylaxis have come more and more to dominate the consideration of the social, economic, and medical aspects of the great problem presented by the universal prevalence of tuberculosis.

While it is everywhere recognized that great progress has been made in the treatment of the various forms of this disease by the development of the hygienic, climatic, and dietetic phases of the subject, and while the earlier recognition of the pulmonary form of tuberculosis has, and is still, very largely increasing the percentage of cases of pulmonary tuberculosis, which may properly be brought within the scope of treatment, and while bacteriological researches have contributed much information, which gives promise of ultimate success in the specific treatment of this disease, yet we are realizing more fully each year that the solution of the problem looks forward to the development of more efficient and far-reaching measures of governmental control.

It is the administrative control, with prophylaxis chiefly in view, which is growing most in importance, and a very hopeful sign of the times in this respect is the increasing acceptance by sanitary authorities of a broader conception of their functions and duties with reference to this disease. Of course, in the ultimate analysis the prophylaxis of tuberculosis is connected with all those fundamental problems which have to do with the lives of the lower and middle classes of society; those relating to the hygienic conditions obtaining in their homes and workshops, such as lighting, heating, ventilation, plumbing, and the air space; the relative width of the streets and the height of the buildings; small parks and open spaces; the purity and character of the food-supplies; the regulation of the hours and condition of labor, matters relating to school hygiene, and numerous other similar considerations.

The questions relating to immediate prophylaxis as connected with the infection possibly surrounding the affected individual have to do primarily with his education and with the development of a sense of responsibility in him for the adoption of precautionary measures, as well as the growth of an intelligent demand on the part of the well, that they shall be subjected to no needless exposure because of the care-

lessness of the sick. With this, too, there must come a more general recognition of the duty of the sanitary authorities to exercise more strict police surveillance over tuberculous individuals, and, when necessary for the protection of others, to insist on the forcible removal to institutions of persons who are unable or unwilling to take these precautions which are necessary to render them free of danger to other persons.

It has come to be pretty generally recognized as the duty of the authorities to provide sufficient facilities for the treatment of these patients in dispensaries, hospitals, sanatoria, day camps, etc.

As long as the problem of prophylaxis is so intimately associated with the fundamental conditions of life of the masses of the population, we cannot hope for any early and complete eradication of this disease, but we may very properly hope for and expect that there shall be a fairly regular and continuous decrease in the prevalence of tuberculosis in all well-regulated communities. The time is not far distant when the lack of proper measures of precaution in any community will be regarded as proof of negligence and incompetence on the part of the sanitary authorities and gross indifference to their own welfare on the part of the general public.

CHAPTER I

INDIVIDUAL PROPHYLAXIS

By EDWARD R. BALDWIN

MEASURES FOR THE HEALTHY INDIVIDUAL

The efficacious prevention of tuberculosis involves the protection of the healthy individual from needless exposure to the infection, so far as is possible. Since, however, complete annihilation of infective material cannot be contemplated in a generation or two at least, measures to minimize the danger by reducing the amount and frequency of exposure on the one hand, and to increase the resistance of the healthy individual to the inevitable exposure on the other hand, must be depended on at present. These measures can hardly be less important in causing the gradual extinction of tuberculosis than those directed toward the control of the consumptive individual himself, considering the present state of civilization.

The protective measures must also be viewed as to their importance in inverse proportion to the age of the individual. Precautions which are of the utmost importance for young infants become almost superfluous for adults, when we consider the greater relative resistance of the latter to infection.

Infancy.—Nontuberculous Parentage.—The most enlightened opinions as to the danger of infection to the youngest infants justify every precaution that can be taken in the isolation and feeding of the new-born, whether the parents are apparently free from tuberculosis or not. Unsuspected tuberculosis in the parents is very common. If the mother has had a latent focus, there is no time more propitious for it to become active than during parturition and lactation. Consequently, obscure ailments in the mother or wet-nurse, especially when accompanied by fever or cough, should be the signal to discontinue breast feeding if tuberculosis cannot be excluded.

Milk.—The necessity for artificial feeding involves infinite care to insure against the danger of conveying tubercle bacilli in the milk. The ideal conditions are to have the absolute assurance that tuberculin-tested cows constitute the only source of the milk, and that, in its

handling or transportation, no tuberculous person is employed; furthermore, that exposure to dust or insects does not occur. When these conditions can be fulfilled no danger can be apprehended from the use of raw milk, but in the complexity of city life few can have these advantages. Hence, sterilization in some form becomes the only safeguard.

Pasteurization leads among all methods for accomplishing this end. The suspicion that milk has been exposed in public places should be reason enough to have it pasteurized; nor should it be forgotten that it may be contaminated after pasteurization if carelessly exposed, and that cream requires the same precautions. The heating should be done in a closed vessel, otherwise the surface layer will not be sterilized. The addition of *antiseptics,* such as formalin and boric acid, cannot be justified either on the ground of efficiency in killing the bacillus or of harmlessness. The least objectionable method is that of adding hydrogen peroxid (Budde). The modifications introduced by De Waele, Sugg, and Vandevelde, and also Much and Roemer ("perhydrase"), by which the H_2O_2 is decomposed by a blood enzyme after acting as an antiseptic, have thus far had insufficient trial to prove their reliability.

Tuberculous relatives or other members of the household, such as nurses, servants, visiting guests, or boarders, should be prevented from coming into close contact with infants if these persons have open tuberculosis. They should avoid kissing the infant and coughing when near it. They should neither be permitted to prepare nor taste the food, nor offer it in the same cups, glasses, or spoons which they are themselves in the act of using, as is so frequently done among the poor.

The ever-ready *handkerchief* forms a dangerous weapon with which to wipe the infant's hands and mouth, and the custom is widespread among otherwise cleanly women of expectorating into handkerchiefs. The unwashed fingers of relatives too often find their way into the infant's mouth, or during the teething period contaminate its fingers and toys, thus indirectly carrying infection obtained elsewhere. Likewise *pets,* especially dogs, who are in the habit of lying on the sidewalks and steps, may become soiled with sputum and convey infection to the nursery.

Overshoes, walking boots, and *skirts* should not be neglected as possible sources of danger to the creeping infant, and they should not be cleaned in any living room. It is of the greatest importance to have the floor of the nursery frequently cleaned and covered, if at all, with movable rugs and matting.

Traveling in public conveyances with infants probably involves less danger of tuberculous infection than is popularly supposed, inasmuch as the chance contact is of short duration. Infants should not be seated

in coaches where antispitting ordinances are not enforced and where dusting of clothing is permitted, if such exposure can be avoided.

Visiting public resorts and houses where tuberculous persons reside is to be discouraged on general principles, though the danger to infants is conceivably far less than from other diseases. Public halls, waiting rooms, and amusement places in general are likewise to be avoided so far as possible. The monkey house of the zoölogical gardens is a place of danger by reason of the frequency of the disease in these animals.

Diseases, especially the exanthematous infections, which give favorable times and places for the reception and development of tuberculosis, should not be dealt with lightly by the laity. Whooping cough, diphtheria, and tonsillitis present all the favoring conditions for infection through the air passages, while gastroenteritis gives the opportunity for its entrance by way of the intestine. The gradual extinction of the acute infections by efficient quarantine and sanitation will doubtless go far toward decreasing tuberculosis, which would often fail to develop when the infection is feeble but for them.

Extra precaution should be taken with children known to have adenitis that they shall not be exposed unnecessarily to children's diseases, or under the instruction of a tuberculous teacher or governess. *Enlarged tonsils,* whether faucial or pharyngeal, are a menace of tuberculous infection either actual or potential, and removal is indicated in nearly all cases. It is highly probable that the gateway of infection is thereby sealed in many cases by timely operation. In any case, mouth-breathing is to be remedied if it has resulted from these causes. *Carious teeth* should be removed and the gums protected from ulceration.

Digestive disturbances are frequently caused by careless feeding of children. They should be restricted as to sweets, and taught to avoid unripe fruit and gluttony. The presence of intestinal catarrh or gastric dyspepsia paves the way for infection otherwise unlikely to gain a foothold.

Accidents.—Falls on the head, blows, or concussion of any kind should be guarded against, for the popular idea of their connection with a subsequent meningeal joint or bone tuberculosis has considerable foundation in clinical experience.

Inoculation tuberculosis from scratches is sufficiently common to require care in covering eczematous patches on the skin of infants, and to observe scrupulous cleanliness with their hands and toys during the period of teething. The possibility of conveying tubercle bacilli by means of *insects* should be guarded against by screening sleeping infants. *Vaccination* has no longer any reason to be charged with the inoculation of tuberculosis where calf virus is used. Only the grossest

carelessness and neglect could produce such a result. The same may be said of circumcision.

Tuberculous Parentage.—When one or both parents have tuberculosis, there are numerous precautions to be taken if complete isolation of the infant is not feasible.

Isolation: When Necessary.—Even with the most minute attention to details, the presence of open tuberculosis in a mother almost inevitably involves some danger of infection to her infant when it is under her care. The tuberculous father can readily avoid close contact with his child; not so the mother, who, though she may not nurse the babe, must prepare its food and attend to its wants because there is no other person to do it. Complete isolation is, therefore, logically the ideal for the infant with a tuberculous mother who is expectorating bacilli. If the disease is latent or already healed, there can be no danger for the infant, though the wisdom of breast feeding by the mother for her own and the infant's interest must be a question in every case.

The possibility of obtaining the infection directly from the milk is very remote even where active tuberculosis exists, unless the mammary gland is involved, but the nipples are readily soiled by the mother's fingers under these conditions, and may thus indirectly convey the bacilli. Besides the conveyance of infection in the milk, the possibility of transmission of a specific susceptibility to the disease is to be regarded, though actual proof of this is not easily obtained. Where the tuberculous parents must of necessity associate closely with the infant, the danger can be reduced to a minimum by avoidance of coughing in the immediate vicinity of the infant, carefully shielding the mouth during the act, and by careful attention to all the other details of personal hygiene elsewhere mentioned for tuberculous individuals.

Special measures directed toward increasing the resistance of the infant are of the utmost value, and the most important is care in feeding. Proper modification of cow's milk, suited to the age and capacity of the nursling, as well as regularity in feeding, should be secured. In this way frequent gastrointestinal catarrhs may be avoided which doubtless favor the lodgment of tubercle bacilli, when otherwise they would not gain entrance. Constipation is only second in importance in favoring infection and must be combated with mild measures.

Immunized Milk.—The possibility of conveying antibodies from immunized cow's milk which shall avail to increase the resistance of infants has received some experimental support. Figari, v. Behring, Roemer, and Much have demonstrated increased agglutinative power for tubercle bacilli in such milk and its transference to offspring. The activity of this and other hypothetic antagonistic substances, nevertheless, appears to be rather restricted, since it has been found (Roemer)

that only during the first eight days after birth are proteid substances absorbed unchanged by digestive action. The advantage resulting from the employment of such milk for infants is largely theoretic at present. But little application has been made of the principle, and it is premature to venture an opinion of its possibilities.

Active immunization of infants by means of feeding tubercle bacilli or their products, made innocuous in various ways, has a promise of application in the future since success has been obtained with suckling calves and guinea pigs, in the experiments of Calmette, Guerin, and Morin.

General Hygiene, Climate, etc.—Much can be done by intelligent care to strengthen infants against infection by keeping them out of doors in all weather except the most severe heat and cold. The morning nap may profitably be taken on a sheltered veranda in cool weather, where safety and quiet can be assured, or in a cold room if this is not available. Catarrhal colds may be warded off by cool sponging and friction to the neck and chest, suiting the temperature to the growth and daily condition of the infant. Favorable climatic conditions, if possible, should be secured for the offspring of tuberculous parents. Those who are congenitally delicate and persistently under-nourished thrive best in Southern California or the southern Atlantic States in winter, especially among the pines and on the coast. Infants with normal assimilative powers are better in the highlands of Colorado, North Carolina, or the Adirondacks, both winter and summer.

Childhood.—The same recommendations can be made with more insistence for children over two years of age, because the opportunity for outdoor life is greater with increasing age and invigorating measures are more effective.

Food.—With the weaning of a breast-fed infant begins whatever opportunity for food infection there may be from other sources. So far as evidence has been adduced, there is little danger outside of milk and its products, butter and cheese. The contamination of food is, however, easier with the greater freedom of movement enjoyed by the child. Bread, cakes, fruit, and confectionery are occasionally handled by tuberculous persons at the shops, and often soiled by dirty hands. The child plays on the floor or sidewalk, handles door knobs and latches, public cups, and innumerable other things used in common which may convey infection. Fortunately these sources do not constitute a great danger in nontuberculous families. Attention to cleanliness is the prime factor of safety here as in all else that concerns prophylaxis. The food should be abundant and especially rich in fats and proteids for children of tuberculous parentage. The butter- and cream-eating habit should be encouraged in such children. A liking for cod-liver oil is not infrequently acquired by children with advantage.

Clothing.—When children are congenitally malnourished, it must not be thought that their clothing is an indifferent matter. They require more underclothing than the better-nourished children, preferably wool next the skin in winter, and especial care to prevent wetting the feet. Bare legs and arms in cold weather are certainly irrational measures for the purpose of hardening most children, however successful with some. Head covering in hot sunshine should always be provided for children. The neck and chest should not be confined tightly nor bundled warmly except in coldest weather.

Bathing and Exercise.—A morning sponge with cool water and a warm tub bath twice a week at night, merit constant attention for delicate children; the habit is then formed early and increased resistance to changes of temperature is acquired.

The question of sea- or fresh-water bathing in the open is an important one for the physician to decide for each individual. No rules can be laid down except the general ones that the time spent in the water should never be long enough to produce cyanosis and pronounced chilliness, and also the warning against entering the water when overheated or directly after meals. Injury has often resulted from neglect by parents and physicians in this matter, by which the foundation for a future pulmonary tuberculosis is laid.

Exhaustion from overrunning and excessive play is a frequent source of illness and debility in delicate children, especially those of active mentality, not unusual among children of tuberculous parentage. Violent games should be discouraged for any child suspected of latent lymphatic, bone, or joint tuberculosis. On the other hand, calisthenics and the respiratory exercises recommended by Knopf are very important in developing weakly children.

Sleep.—Children under fifteen years of age require from ten to twelve hours sleep daily. Some are benefited by an after-luncheon nap, but this leads to the temptation to keep a wide-awake child up later in the evening. Delicate children must be prevented from frequent attendance at evening parties. Unless suffering from recent colds or diseases, children should sleep in cool rooms, with at least one window open. Night clothing of flannel, with foot covering, is desirable for cold weather.

Habits.—No time can be better spent for the prevention of tuberculosis than in teaching cleanly habits to young children. It should be the constant aim of parents and teachers to keep the hands and nails of children clean, to prevent picking of the nose and scratching of abraded surfaces, herpetic or eczematous patches, etc., which may thus be the source of inoculation tuberculosis. The sanitary instruction now being introduced into public schools promises much in the furtherance of prevention.

The following brief presentation of simple health rules was made by the Hawthorne Club, a group of tenement-house children in Boston:

HEALTH RULES FOR SCHOOL CHILDREN

1. Health is wealth.
2. Do not put pins in your mouth.
3. Do not hold money in your mouth.
4. Do not put your fingers in your mouth.
5. Do not put pencils in your mouth or wet them with your lips.
6. Do not wet your finger in your mouth when turning the leaves of books.
7. Do not put anything into your mouth except food and drink.
8. Never spit on your slate or on the floor or sidewalk.
9. Do not pick your nose or wipe it with your hand or sleeve.
10. Keep your face, hands, and finger nails clean.
11. Keep the interior of your body clean by allowing nothing to go into it excepting pure food and pure drink.
12. Do not keep your rubbers on in the schoolroom.
13. Do not sit with wet feet or damp clothing; resort to the stove or register until they are dry.
14. Do not swap parts of apples, candy, chewing gum, half-eaten food, whistles, or anything that is to be put in the mouth.
15. Never cough or sneeze in a person's face. Turn your face to one side and hold a handkerchief before your mouth.
16. When drinking, rinse out the cup, and empty what water you leave into the wash basin or sink.
17. Breathe only fresh air day and night; simply avoid draughts.
18. Breathe, sit, stand, and walk correctly. In so doing you will do more to prevent consumption than all the physicians combined. A good pair of lungs is the most efficacious barrier to this disease.
19. Go to bed early, rise early, and take plenty of "physical culture," helping father and mother, before and after school, with the "chores."
20. Study the physiology—to know how to use rightly and take proper care of every part of the body.

Schooling.—The amount of strain which schooling brings to a child must be considered carefully, particularly with children of tuberculous parentage, whether they are already infected or not. Apart from the danger of infectious diseases likely to be acquired at school—especially measles, whooping cough, scarlet fever, and diphtheria—the well-known precocity and intellectual keenness of many such children is a reason for restraint rather than stimulus in study, and the family physician may properly err on the side of overwillingness to grant certificates asking for shorter hours and absences to these children. Work at home or elsewhere, when it restricts outdoor life and the normal development, should be abolished by law.

An excellent scheme for keeping children out of doors in cities is the roof garden devised and successfully used by Dr. Northrup in New York (see Fig. 122).

Youth.—*Period of Puberty.*—With the advent of sexual consciousness, a period of danger arrives in relation to tuberculosis. It is chiefly with those children who have already become infected that the fear of an outbreak should be greatest, for the actual danger of primary infection is probably less during the years of adolescence when active outdoor life is the rule. Rapid growth and instability of the nervous system tend to favor the spread of latent disease, and the suspicion of any focus of this kind should lead to constant watchfulness. Periodic examinations by the physician are strongly to be recommended, and much depends on his care and tact with delicate youths. Avoidance of masturbation can be taught best by the family physician, and its debasing moral and physical effects presented in a judicious way, supplementing the generally desultory efforts of parents and teachers. Signs of chlorosis or markedly irregular menstruation in girls call for increased vigilance in reference to latent tuberculosis.

Overstrain has been the bane of modern life for adolescents. Exhausting wheeling trips and racing of all kinds are common. Athletic contests and overtraining are associated with the development of tuberculosis with sufficient frequence, even in the robust, to justify constant restraint. The presence of latent tuberculosis has often been unsuspected by physical directors, and more care is required in obtaining the previous histories of candidates for college teams. Mental and nervous strain is to be prevented quite as much as physical overexertion, for the latter naturally concerns the strong, while overstudy and nervous excitement oftener affect the less vigorous. Late and irregular hours, insufficient sleep, excessive smoking, eating, and drinking, combine to undermine the resistance of many college youths who have inherited or acquired susceptibility to the disease.

Moral training is especially important for venereal prophylaxis, and has been sadly wanting in the past. Fortunately, educators and publicists are now endeavoring to supplement the efforts of physicians in this direction, and a potent factor at the root of much tuberculosis is being grappled with. Nevertheless, the most effective work is that which may be done by the personal influence of the physician.

Adult.—*Promotion of Good Physique.*—When full growth is attained and the life work entered on, individuals with delicate constitutions are the first to contribute to the harvest of tuberculosis, which is always greatest at the threshold of married, business, and professional life. The open-air life of youth is abandoned, and responsibilities accumulate which tend to lower resistance by their demands on the physical

and mental powers. Nor can it be forgotten that the strongest sometimes succumb. None can be excluded in the application of rules of hygiene. Good muscular vigor should be furthered by walking, deep breathing, and open-air sports generally. Golf is one of the foremost useful games for sedentary persons, while driving and boating are especially good for those more actively employed and required to stand

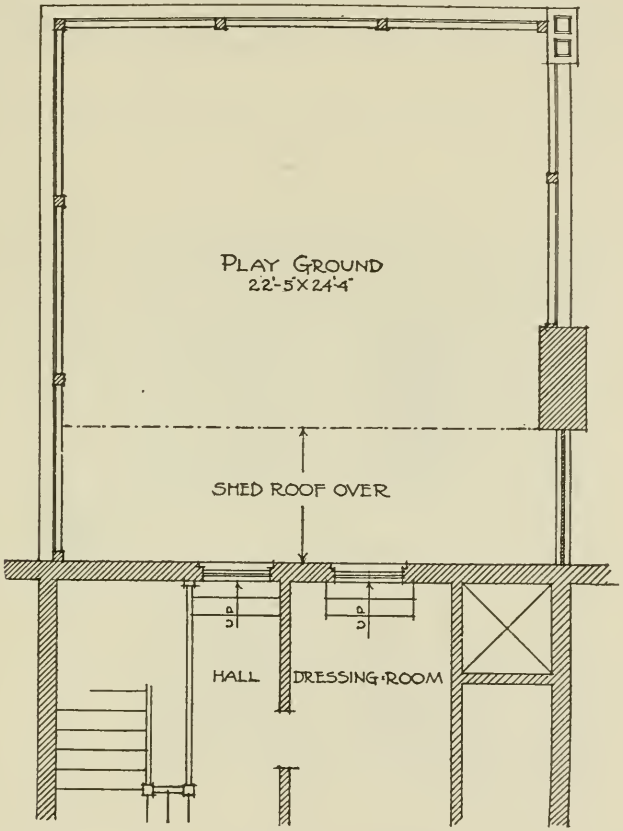


FIG. 122.—PLAYGROUND ON ROOF OF RESIDENCE IN NEW YORK CITY. (Dr. Northrup).

much on their feet. It is often important that otherwise desirable indoor recreation be replaced by outdoor work, such as gardening. On the other hand, mental recreation is highly important to maintain vigorous intellectual power and, indirectly, a stable nervous system, so often lacking in persons predisposed to tuberculosis.

Habits.—Regularity and temperance in all things are requisite for the maintenance of good resistance in the strong, and doubly so in

persons predisposed to tuberculosis. Even moderate dissipation may arouse a latent infection into activity, so that alcohol, tobacco, and late suppers can be dispensed with by such individuals. Temporary exhaustion from excesses of any kind is readily forgotten until a breakdown occurs, so that constant warnings are needed. Carefulness in dress so as to avoid chilling and wetting, in diet and eating that the necessary time is taken for proper mastication, and in sleeping that fresh air is obtained, should be insisted on specifically and often by the family physician; otherwise gradual neglect of simple hygiene commonly prevails in most families.

Occupation.—In the choice of an occupation everyone should have the advice of a physician familiar with the physique of the family, if

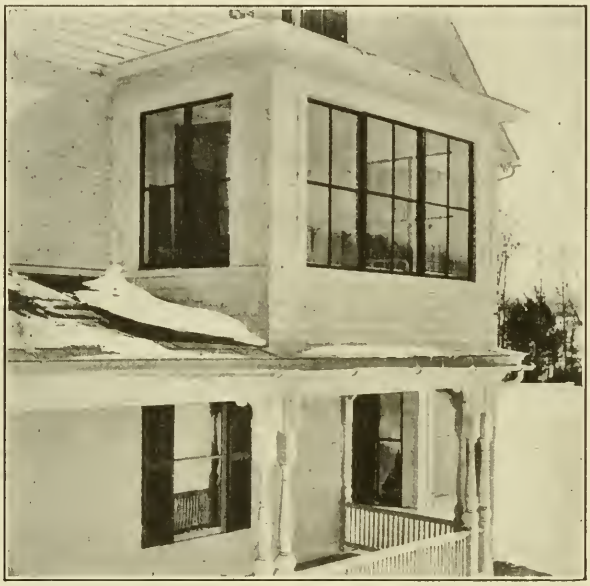


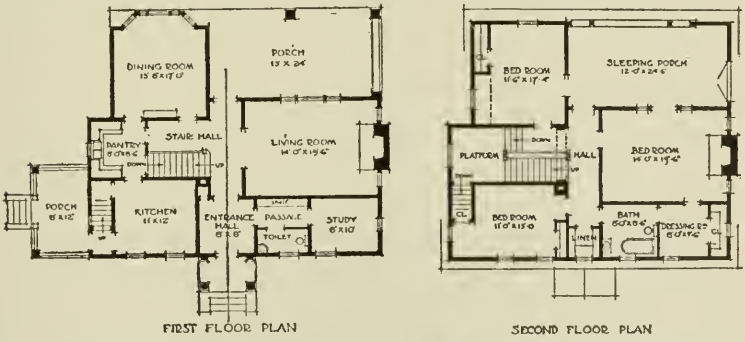
Fig. 123.—Sleeping Balcony. (Private house, Saranac Lake, N. Y.)

possible. Too often necessity drives ill-nourished, thin-chested individuals, and those who are physically under-developed, into an indoor trade or behind the counter. Practically all the "light" occupations are indoors, so that the problem is not what occupation to select which will give the individual an outdoor life, but how one can be adjusted to it so as to get the most time in the open air and have healthful working conditions indoors. Dusty employment should not be permitted for persons predisposed or those already the victims of latent tuberculosis, nor should trades that involve exposure to wetting, steam, vapor, and

extremes of temperature, like confectioners, bakers, and plumbers, be selected by any person who may be predisposed to tuberculosis. Clerical and professional pursuits, involving as they often do great mental strain, ought not to be undertaken by very excitable, nervously constituted individuals. Where possible, such persons should be guided into agricultural or allied occupations. The transportation, mail, and express services offer many desirable places for open-air employment.

Dwellings.—Modern urban life is inexorable in its crowding, with consequent restricted light and air. It should be the aim of families which have had tuberculosis among their members, or which, for any reason, are predisposed, to secure a suburban house isolated from others so that all sides may receive light and air. No unlighted hallways, basement rooms, or damp cellars should be permitted. Houses in swampy regions should be abandoned for higher and drier locations. Heating furnaces or radiators should be furnished with water evaporation tanks to prevent undue dryness. Dry sweeping should be forbidden. Living rooms in winter should not be warmer than 68° F., and the windows should frequently be opened at the top. A sleeping room with balcony or with provision for a bed practically out of doors is very desirable for any family, but especially for the one with a delicate member who is predisposed to pulmonary disease. Much attention should be given to a spacious veranda to make it available for both summer and winter as a place for rest and comfort (see Fig. 123).

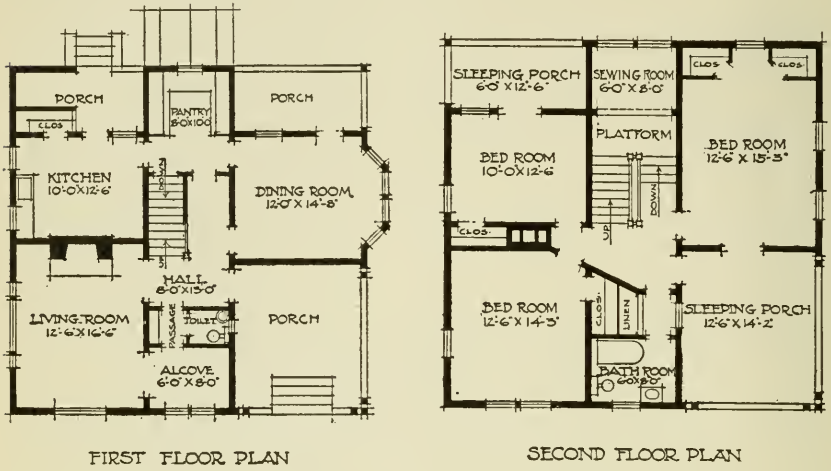
Houses with sleeping porches entering into the building plan are being constructed more and more. They are worthy of imitation. The two adjoining plans may be more suggestive (see Figs. 124 to 127).



FIGS. 124 and 125.—COTTAGE SHOWING ARRANGEMENT FOR ONE SLEEPING PORCH. (First and second floor plans.) (Scopes & Feustmann, architects, Saranac Lake, N. Y.)

Marriage.—The question of marriage, in relation to the danger of tuberculosis, is not often first referred to the physician, yet serious

danger might be averted in some cases by his wise counsel. The things most important to consider for the husband are his physical ability to bear the strain of supporting a wife and children by his own efforts,



FIRST FLOOR PLAN SECOND FLOOR PLAN

FIGS. 126 and 127.—COTTAGE SHOWING ARRANGEMENT FOR TWO SLEEPING PORCHES. (First and second floor plans.) (W. E. Scopes, Architect, Saranac Lake, N. Y.)

if that is to be required of him by necessity or choice. If he is delicately organized, and has a struggle before him, there is a real danger that tuberculosis may claim him, yet if life is comparatively easy, and the wife strong, the union may be free from serious objection. The children may also acquire excellent constitutions in spite of the paternal weakness, unless syphilis or some other taint is added. On the other hand, a delicate woman must undergo grave danger of tuberculosis from child-bearing if latent disease is present or the conditions of life involve exposure to it. Each case must be decided on its individual indications and contraindications, consideration being given to the temperaments, social status, and prospect of greater or lesser hardships in the married state.

MEASURES FOR TUBERCULOUS INDIVIDUALS

Closed Tuberculosis.—Numerous cases of closed (latent or healed) tuberculosis have come to light in recent years owing to the greater attention given to early diagnosis and the use of newer diagnostic aids, especially tuberculin. Many tuberculous families are now being systematically examined, and medical inspection of school children, combined with special tuberculosis dispensaries, promise to reveal an enormous number of infected individuals. Adequate public and private preventive

agencies will not fail in the future to take more and more note of latent tuberculosis. All that has been mentioned in the preceding pages on prophylaxis applies especially to these dormant tuberculoses which may often be prevented from spreading further by good care.

Scrofulosis.—Every effort should be made to prevent suppuration and ulceration of scrofulous glands. Bone and joint abscesses under modern surgical treatment can often be prevented from rupture and secondary infection. If rupture occurs and drainage becomes necessary, it must be kept in mind that the pus contains tubercle bacilli and that the discharges from the sinuses must not be neglected simply because it is not easy to discover the bacilli in them.

Closed Pulmonary Tuberculosis.—This may so readily become open, without warning symptoms, that it is wiser to provide for this contingency by observing the rules for the care of the cough and expectoration, if present. If these precautions were more generally carried out, "locking the door" after the harm is done would be less common.

Open Tuberculosis.—Care of the Sputum.—There is no doubt about the advantages of asepsis over antisepsis in dealing with tuberculous sputum. Reliance on disinfectants begets uncleanliness in handling cuspidors or other receptacles. Hence, with the most efficient germicides less is accomplished than with a liberal use of soap and water and the destruction of expectoration by fire or boiling heat. Moreover, most of the useful disinfectants have a disagreeable odor, coagulate the sputum, and injure the skin, besides being poisonous.

Handkerchiefs.—The use of washable handkerchiefs should be strictly forbidden, and cloth, gauze, or paper handkerchiefs substituted for all purposes. The repeated use of the same handkerchief or cloth for sputum is absolutely unhygienic, in that the hands will be unavoidably soiled and flakes of dried mucus are soon formed and scattered from the cloth. If handkerchiefs have of necessity been used, they should be burned or soaked in boiling soapsuds or some alkaline disinfectant, such as a two-per-cent chlorinated lime solution or a two-per-cent lysol solution before being laundered. The ordinary soiled clothes bag is not a sanitary place for any handkerchiefs. A better plan is to collect all handkerchiefs in a covered slop jar during the week and pour boiling suds on them before removal to the laundry. Cloth or bandage rolls for receiving the sputum are objectionable because the fingers become soiled in rolling them. Pieces of gauze and paper handkerchiefs should also be folded several thicknesses for the same reason. Paper bags are the most satisfactory receptacles for sputum cloths. Rubber pocket linings are less available and require cleansing, whereas the bags are to be burned.

Cuspidors.—Those made of paper are now in general use, and are preferable to metal or glass ones because no cleansing is required. This consideration applies to all forms of cuspidors, whether for the pocket or stand. There are, however, several excellent metal and glass pocket cuspidors, such as Knopf's, Kny-Scherer's, and Dettweiler's, which can be filled partly with a disinfectant when in use. Floor and wall cuspidors should be abolished as fast as the pocket receptacles can be introduced to take their places. Portable cuspidors in great variety are to be had which are quite sanitary. Only such should be permitted as have a cover, so as to prevent the access of flies. Paper cups should be placed in frames of sufficient weight to prevent their capsizing or being blown about by wind. Cuspidors of agate ware or china should be cleansed with strongly alkaline soap and hot water, the sputum having been burned, or after disinfection poured into a water closet (see illustrations in Appendix, pages 832–839).

Disinfection.—It should be a constant aim to burn all sputum where possible. Admixture with sawdust, paper, and cloth greatly facilitates the burning, but care should be taken that the fire is sufficiently strong to completely destroy everything. Boiling is also efficient, but not ordinarily feasible, outside of institutions. The alkaline disinfectants are the best, but have an objectionable odor in most cases. A two-per-cent solution of chlorinated soda and lime is most economical but more volatile than lysol (2 per cent). Caustic soda (10 per cent) is satisfactory for public cuspidors, but requires careful handling to avoid injury to floors, etc. Mercuric chlorid (0.1 per cent), phenol (5 per cent), and formalin (2 per cent) are coagulants which act too slowly for most purposes, but may be useful where sputum has been accidentally spilled on a carpet or floor. Cuspidors require more careful washing when these have been used. Formalin fumigation should be relied on for the disinfection of garments, rugs, and other nonwashable objects. Where a public fumigatory is not available, a closet or room can be utilized and the formaldehyde generated by the fireless method.[1]

Cough Discipline.—A well-trained and conscientious consumptive can do much to minimize the danger from accidentally coughed-out

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[1] For each 1,000 cubic feet of space disinfected take 3 ounces of commercial sulphuric acid, add it to 1 pint of water and pour into 18 ounces of commercial formalin in a vessel of crockery or agate ware. This warm mixture is then poured quickly on 1½ pounds of fresh unslaked lime, broken into small lumps in an agate or iron kettle, and placed on the floor protected by papers. The formaldehyde vapor is rapidly generated so that it is necessary to close the door at once, all openings having previously been pasted over with paper. The door is then sealed for twelve hours, after which the room may be opened and the contents removed for airing and cleaning.

sputum spray by repressing the cough and covering the mouth when coughing. This can be cultivated to a marked degree by resisting the tendency until the sputum can be raised without effort. Fraenkel's mask was introduced for the purpose of arresting the cough spray, but it has found but little favor. Simpler measures are the only ones likely to be carried out in practice, and the habit of covering the mouth with cloth is readily acquired. Hawking and sneezing should be suppressed if possible, and the mouth and nose especially covered during these acts. The head should always be turned away during the act of coughing and raising in the presence of other persons. It is surprising how many persons forget hygienic breeding, or lack alertness in practice! The patient should endeavor, as far as possible, to do his coughing in his own room or out of doors, repressing it elsewhere.

Personal Cleanliness.—The whole law and gospel of properly trained tuberculous patients are contained in the expression "Be ye clean." This is of paramount importance and needs intelligence to be carried out consistently. Patients who gargle and wash their mouths carefully, yet swallow their sputum consciously or unconsciously, are endangering the intestinal tract. Likewise, those who brush their teeth carefully, but wear drooping mustaches or a beard often smeared with sputum, are not fulfilling the law.

Effective cleanliness begins with mouth-washing [1] and gargling after the morning cough has dislodged and raised the sputum. Nothing should be swallowed until this has been accomplished to as great a degree as possible. The teeth are then to be brushed and a nasal spray or douche used if much catarrh is present. An alkaline cleansing spray is also desirable for a catarrhal larynx and important when this is tuberculous. These procedures prevent to some degree autoinfection or reinfection of the ears, nose, larynx, and intestine, while frequent and plentiful use of soap and water for the hands and face avoids much chance of conveying infection to others.

Mustaches and beards are difficult to maintain in a state of sanitary

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[1] *Mouth Wash.*

℞ Olei gaultheriæ	♏	xxxvj	2.3 gm.
Olei eucalypti	♏	xxx	2 "
Mentholi	gr.	xx	1.3 "
Thymoli	ʒ	j	4 "
Acidi benzoici	ʒ	iv	16 "
Acidi borici	ʒ	j	30 "
Sodii bicarb	ʒ	j	30 "
Extr. baptisiæ tinctoriæ	f ʒ	iij	12 "
Alcohol	O	iij	720 "
Aquæ	O	v	1200 "

M. With equal parts of water. S. Use as mouth wash.

cleanliness unless closely trimmed, and should be shaven when the expectoration is profuse. Patients should be cautioned against handling articles used by children, leaving cloths or handkerchiefs in books, overcoat pockets, bureau drawers, and closets, and also against permitting glasses, spoons, pipes, cigar butts, and toothpicks to lie about and get dry. However insignificant taken singly, all these precautions are in the aggregate justifiable and reasonable.

Care of Other Excretions.—The urine and feces are to be considered secondary in importance to the sputum, but soiled underclothing and bedding should be soaked before being handled in a laundry, and especially where renal, vesical, or intestinal tuberculosis is known to be present. Abrasions of the genital organs, especially of the female, should be kept surgically clean in the tuberculous.

Duty of Consumptive Individual to Society.—Every tuberculous person owes a duty to his fellow human beings to the extent of protecting them so far as possible from his disease. He cannot rightfully scatter infection about because it is some trouble and sacrifice for him to avoid this, and because he may have acquired the disease through no fault of his own. Nay, more, he may not justify carelessness if his disease is the direct and acknowledged result of public neglect. The rule must apply here as in all infectious diseases, although restraint of freedom beyond recognized limits is very much less justified. Quarantine of a tuberculous patient cannot be upheld unless he is shown to be viciously dirty and knowingly careless. Isolation for the tuberculous insane and imbecile or the hopelessly ignorant and depraved patient is logically demanded, but not for the intelligent and obedient in the present state of society and widespread prevalence of the disease.

On the part of the patient, voluntary isolation cannot be expected, yet it is desirable that he should avoid undue publicity in manifesting the symptoms, which may cause him embarrassment and increase the prejudice of the inconsiderate public. This is especially true of advanced cases with severe cough and hoarseness when in public places, such as street cars, waiting rooms, theaters, churches, hotels, and especially restaurants.

Duty of Society to Consumptive Individual.—The careful, cleanly consumptive has a right to associate with other people in the ordinary pursuits of business and pleasure. He also should have the right to consideration and sympathy as well as charitable aid when in need. He can justly meet the demands of society for his isolation or abandonment of occupation by the counter demand for a place of retreat or another occupation. Society, through government, should provide instruction to the afflicted individual in the means of prevention and cure, and not greatly restrict his liberty provided he obeys these instructions.

Phthisiophobia has been an increasingly serious matter for several years, and the popular lecturer on tuberculosis cannot avoid conveying exaggerated ideas of the dangers of infection. When the public is told that a dirty consumptive is dangerous, the inference that all consumptives are dangerous is irresistible to many persons. Argument and statistics do not accomplish much to counteract this unjust impression, and it behooves all right-minded physicians to throw the weight of their personal influence against exaggeration.

Marriage should not be contracted by tuberculous persons until two years after their recovery, except under special conditions. Where a complete arrest of the disease is obtained, though not a clinical cure, marriage and procreation may sometimes be permitted with safety under favorable conditions of life in other respects. Circumstances arise where the marriage of consumptives is quite justifiable, but in nearly all of these cases the procreation of offspring should be forbidden in a consumptive wife. The interest of the mother and child alike demand this course, yet if pregnancy occurs, the induction of abortion becomes a question to be decided in each case and not by rule. When the husband is consumptive, the interest of the mother and child are less endangered, but usually sufficiently so as to preclude procreation. Considerations of a nonmedical character must frequently determine the decision and remove the matter from the physician's control.

ADDENDA

Summary of Individual Prophylaxis, Presented at the International Congress, held in Washington, D. C.

While no fundamentally new contributions have been made to methods of individual prophylaxis, a great number of investigations of tuberculosis in childhood have again emphasized the necessity of purposeful efforts in early childhood.

The enormous number of infected children is only recently becoming realized and emphasized by the results of examinations. Miller and Woodruff found 51 per cent in 150 children of tuberculous parentage. Floyd and Hawes in 900 children found 66 per cent distinctly tuberculous, the majority of whom were exposed at home. Lowman and Sachs have also found similar conditions.

Suggestive as regards the attempted immunization of children by feeding them with milk from immunized animals is W. J. Butler's finding that opsonic substances are practically absent in milk of healthy women.

CHAPTER II

PUBLIC MEASURES IN THE PROPHYLAXIS OF TUBERCULOSIS

By S. ADOLPHUS KNOPF

Historical Review.—The possibility of the transmission of tuberculous diseases, particularly pulmonary tuberculosis from man to man, was known to some of the ancient Greek and Arabian physicians. Galen (131–200 A.D.) was the first to write of the possible contagiousness of the disease, and Avicenna (980–1037 A.D.), the founder of the Arabian school of medicine, speaks of the contagiousness of phthisis pulmonalis in his "Arabum medicorum principis" and the "Canon medicinæ."

The first scientific demonstration of the transmission of tuberculosis from man to animal was given by the French physician Villemin, in 1865, and the infectiousness of tuberculous meat and milk from tuberculous cattle was first shown by Gerlach and Klebs in 1870.

The first official act pronouncing tuberculosis a contagious disease, giving directions for the disinfection of apartments, furniture, and personal effects used by a consumptive, making it at the same time obligatory for the physician to report cases of consumption to the authorities and prescribing the punishment for failure to do so, was the celebrated royal decree issued in Naples, September 20, 1782. With the beginning of the nineteenth century, however, it was no longer enforced.

After that, for nearly a hundred years, there were only individual efforts on the part of some public officers or local governments to recognize in tuberculosis a communicable disease. A new impulse toward the recognition of the necessity of taking proper precautions and educating the public in regard to tuberculosis as an infectious disease, was given through the epoch-making discovery of the tubercle bacillus by Robert Koch in 1882. Soon after that laws were made and official regulations issued in various countries with the object of the prevention of tuberculosis in men and animals. The first society for the prevention of tuberculosis in the United States was founded in 1892 by Dr. Lawrence F. Flick, of Philadelphia.

France had its first "Congrès pour l'Étude de la Tuberculose chez l'homme et chez les animaux" in 1898. Germany held a congress at

Berlin in 1899, and England followed with one, international in scope, in 1901. There was a similar congress held at Naples in 1906. A truly international congress on tuberculosis convened in Paris in 1905. At the closing session of this congress it was decided to hold the next one in Washington in the autumn of 1908, under the auspices of the National Association for the Study and Prevention of Tuberculosis.

This, the first congress of its kind ever held in the United States, must be considered one of the most successful scientific gatherings which ever convened. Mr. Theodore Roosevelt accepted the presidency of the congress, Koch of Berlin, Williams of London, and Landouzy of Paris were made honorary presidents, the governors of the various States of the Union acting as honorary vice-presidents; representatives from all civilized nations were sent, and the attendance was very large.

Many valuable communications were presented at the section meeting. There were seven of these sections: Section I, "Pathology and Bacteriology," Dr. William H. Welch, president; Section II, "Clinical Study and Therapy of Tuberculosis—Sanatoria, Hospitals, and Dispensaries," Dr. Vincent Y. Bowditch, president; Section III, "Surgery and Orthopedics," Dr. Charles H. Mayo, president; Section IV, "Tuberculosis in Children," Dr. Abraham Jacobi, president; Section V, "Hygienic, Social, Industrial, and Economic Aspects of Tuberculosis." Mr. Edward T. Devine, president; Section VI, "State and Municipal Control of Tuberculosis," Surgeon-General Walter Wyman, president; Section VII, "Tuberculosis in Animals and its Relations to Man," Dr. Leonard Pearson, president.

The meetings were held in the new National Museum, which the United States Government had placed at the disposal of the congress. The tuberculosis exhibition was held in the same building, and it can be said that it was the most instructive ever presented. The exhibition consisted of charts, photographs, maps, models, diagrams, and all sorts of appliances for the prevention, study, and treatment of tuberculosis. Exhibits were shown from 15 different countries, and from 200 associations and individuals. All in all the exhibition included nearly 5,000 units. Numerous awards, prizes, and honorable mentions were given. There were nearly 7,000 inscribed congress members. Some of the distinguished foreign delegates delivered special addresses in Washington and other cities of the Union. The section meetings lasted from September 28th to October 3d, and the social functions of the congress were as interesting and gratifying as the scientific work. At the concluding session, over which Secretary Cortelyou presided, President Roosevelt made an interesting and inspiring address. The delegates present decided to accept the invitation from the Italian Government to hold the next congress in Rome in 1911.

A few historic details from this country may be referred to. The first, and one of the most important, a tuberculosis committee, was founded in 1902 by the Charity Organization Society of New York. Since then numerous similar committees, local and State organizations have been founded.

The national concentration of the work was brought about in 1904 through the foundation of the National Association for the Study and Prevention of Tuberculosis, at a meeting in Philadelphia. Its organization was completed in June of that year, at the time of the meeting of the American Medical Association at Atlantic City. The officers elected were: Edward L. Trudeau, president; William Osler and Herrman M. Biggs, vice-presidents; Henry Barton Jacobs, secretary; and General George M. Sternberg, treasurer. Theodore Roosevelt and the late Grover Cleveland were among the honorary vice-presidents. The offices of the association are in New York City (United Charities Building, 105 East Twenty-second Street).

Dr. Livingston Farrand, the present executive secretary of the association, reports on the gratifying progress made in antituberculosis work in the United States. The great success is in no small measure due to the activity of the National Association and of this efficient executive officer. His report states that there exist in the United States at the present time 195 antituberculosis associations, 240 sanatoria and special hospitals for the tuberculous, and 158 dispensaries exclusively devoted to the treatment and instruction of ambulant tuberculous patients.[1]

The National Association is a member of the International Antituberculosis Association, which has its central bureau in Berlin (Knesebeckstrasse, 29, general secretary, Dr. Pannwitz). This latter association has as members representatives from all the countries of the world in which systematic efforts against tuberculosis are carried on. Twenty-two countries are at present represented with a total membership of about 800.

The object of the association is to encourage those efforts against

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[1] At the present moment the status is as follows:

		Increase
ASSOCIATIONS:		
Number August 1, 1908	195	
Number March 15, 1909	273	78
SANATORIA:		
Number August 1, 1908	240	
Number March 15, 1909	289	49
DISPENSARIES:		
Number August 1, 1908	158	
Number March 15, 1909	217	59

tuberculosis which require international coöperation. These include comparative studies of law and police regulations in regard to the disease, notification, disinfection, segregation of advanced cases, insurance against sickness and invalidity, occupational hygiene, the hygiene of the home, etc. The introduction of uniform methods of gathering statistics, investigations in regard to the spread of tuberculosis to other countries and races are included, and, finally, the scientific inquiry into the causes of tuberculosis (routes of infection, heredity and predisposition, etc.), and of methods of treatment.

For the discussion of these problems annual conferences of the association are held. The association also publishes a monthly journal, *Tuberculosis*, in three languages. This journal is now in its eighth year with a circulation of nearly 3,000. A detailed report on the work done by the International Antituberculosis Association was presented at the last congress by Helm.

Purpose and Scope of Local Antituberculosis Associations.—The purpose and scope of these associations or committees should be: first, the promulgation of the doctrine that tuberculosis is communicable and preventable; second, the dissemination through public lectures, exhibitions with demonstrations, distribution of literature, etc., of knowledge concerning the means and methods of preventing tuberculosis; third, the promotion of all movements which will provide for the tuberculous dispensary facilities and advice stations (class methods), camps, sanatoria, and special hospitals; fourth, the promotion of all efforts tending to prevent the development of tuberculosis and scrofulous diseases by improving the condition of tenements, the erection of model dwellings, the creation of parks, roof gardens, recreation piers, playgrounds, garden schools, baths, gymnasiums, etc.; fifth, coöperation with local municipal, State, or federal authorities with a view of enacting and enforcing laws and regulations against indiscriminate spitting, the use of meat and milk from tuberculous animals, and for the obligatory notification of all cases of tuberculosis to the local health authorities. These plans should be carried out without undue hardships to the tuberculous invalid and their families, or to farmers and dairy men.

The Popular Lecture.—This is best delivered by a general practitioner, preferably a member of the local tuberculosis society. It is well to have several physicians alternate in the task. A public hall or schoolhouse, easily accessible, well lighted and ventilated, is, of course, the most suitable place for this purpose. It will not do to lecture on tuberculosis and on the value of light and pure air in a gloomy, badly ventilated hall. The lecture must be free to all, and delivered at a time when the masses can come to listen. The titles of the lectures should not be grewsome; they should be dignified, encouraging, and inviting—

for example, such as the following, which the writer has used with success: "Our Duties Toward the Consumptive Poor," "The Tuberculosis Problem and How it may be Solved," "The Prevention of Tuberculosis," "The Joyful Message of the Preventability and Curability of Tuberculosis," "Pulmonary Consumption and the Possibilities of its Eradication Through the Combined Action of a Wise Government, Well-trained Physicians, and an Intelligent People," "The Victory Over the Great White Plague," "The Social and Humanitarian Aspects of the Tuberculosis Problem," "The Duties of the Government and the Individual in the Combat of Tuberculosis," "The Successful Warfare Against Tuberculosis."

If the audience is to be composed of women or school teachers, it is well to select titles similar to the following: "Women's Duty in the Fight Against Tuberculosis," "The Teacher's Part in the Antituberculosis Crusade."

Handbills and Invitations to Lectures.—The handbills, circulars, or cards inviting a general or a special public to attend a lecture, should be attractive and to the point. If it can be announced that a prominent officer of the city or State will preside over the meeting, it will add to the prestige of the movement and be likely to attract a larger audience.

It has sometimes been the experience of the writer, as an occasional lecturer before public audiences, to be requested by the committee on arrangement to avoid the words tuberculosis or consumption in the title of his lecture. It was thought by the committee that too suggestive titles might keep a number of sensitive people away. Such titles as, for example, "How May the Health of Our Community be Improved?" "A Health Problem of Interest to Everybody," "Health and Prosperity and How it may be Furthered," might then be used.

Economic Loss to the Commonwealth through Tuberculosis.—In a public lecture on tuberculosis it is well to point out strongly the economic loss accruing to a community which does not take care of its consumptive poor at the right time and at the right place when there is the best possible chance for recovery, but waits until it is too late and then cares for them at the wrong place (county hospital or poor farm). It is best to make such calculations with direct reference to the locality in which the lecture is delivered. Thus, for example, in my own city and State I have been in the habit of giving to my lay audience the following convincing figures: It is estimated that there are in this State about 50,000 tuberculous invalids. Of these probably one fifth belong to that class of patients who sooner or later become a burden to the community. These 10,000 consumptives, absolutely poor, will sooner or later have to be taken care of by the public general hospitals.

While they may not stay in one hospital twelve months continuously, they will certainly occupy a bed in one or other of the public institutions for that length of time before they die. According to a recent report by the public charity hospitals of New York City, the average cost per patient per day in the general hospital is $1.16. Thus, the cost to the commonwealth will be $4,234,000 per year for caring for the 10,000 consumptives.

What would be the expense if they were taken care of in a sanatorium? Experience in this country has demonstrated that the maintenance of incipient cases in well-conducted sanatoria can well be carried out for $1 per day. If these 10,000 persons should be sent to a sanatorium in time, at least 6,000 of them would be cured permanently after a maximum sojourn of two hundred and fifty days, at an average expense of $250 per capita. Thus, for $1,500,000, 6,000 persons would again become breadwinners and useful citizens. If the remaining 4,000 invalids were kept in the sanatorium one year before they died, it would cost $1,460,000. Thus, taking away from the tenement districts 10,000 consumptives, curing more than half of them, caring for the other half, and destroying 10,000 foci of infection will cost $2,960,000. When not taken care of in the earlier stages of this disease they will probably all die, since this 10,000 represents the absolutely poor who now live under most unhygienic conditions; they will have infected a perhaps equally large or larger number of individuals living with them, but before dying they will have cost the community $4,234,000.

Another valuable argument which may well be presented in any public lecture is that relating to the loss which accrues to a community by failing to prevent its people from becoming tuberculous. Besides the loss and sorrow which are naturally felt by the individual and family, the economic loss from tuberculosis sustained by the commonwealth is tremendous. Dr. Thomas Darlington, the Health Commissioner of New York City, in speaking of the cost of tuberculosis in that city, declares in a recent publication: "Estimating the value of a single life at $1,500—not necessarily a high estimate—and taking only the lives between sixteen and forty-five years, the monetary loss of life in that city alone from tuberculosis amounts to the startling sum of $23,000,000 annually."

Dr. John B. Huber, also a close observer, estimates that tuberculosis occasions to the United States an annual loss of at least $330,000,000. One tenth part of this, judicially spent, at the right time and at the right place, for prevention would probably suffice to eradicate the disease within a very few years. This fact should always be impressed upon a public audience.

Protest against Patent Medicines and "Sure Consumption Cures."—It should, furthermore, never be forgotten in a public lecture that much good may be accomplished by a dignified protest against the use of patent medicines and the dangerous and nefarious trade of quacks who advertise "sure consumption cures," claiming some secret method or remedy. A very valuable pamphlet has been issued by our New York Department of Health on so-called "consumption cures." It ought to circulate in every community, and with the substitution of the names of prominent local physicians instead of those of the New York ones. I am convinced that such a circular would do much toward convincing the people that all the so-called sure and quick consumption cures advertised as such are invariably based on false claims.

Character of a Tuberculosis Lecture.—The lecture itself should, of course, be practical and to the point, avoiding too technical and too scientific expressions. It is not always easy to speak the language of science in the language of the people, but one should strive to use plain, simple words and make himself well understood. While a dignified and earnest manner will always appeal to an intelligent audience, the lecture should be enlivened with some bright, cheerful suggestions, and even an occasional witty remark may find its place. If the lecturer is able to speak extemporaneously, it is always the most appealing and successful way to reach a popular audience. But whether the address is extemporaneous or read from manuscript, it should not exceed three quarters of an hour in length. The remaining quarter of an hour should, whenever possible, be devoted to showing stereopticon views, illustrating devices for the prevention and treatment of tuberculosis, such as sputum cups, reclining chairs, window tents, chair half tents, sleeping tents, sleeping shacks, lean-tos, sanatoria and special hospitals.

To illustrate by charts or lantern slides the absolute and relative mortality from tuberculosis in a given locality, and also to show by tables which occupations are particularly conducive to the contraction of tuberculosis, is always interesting and most instructive to a lay audience. While even the illustrations of bacilli may be useful and interesting, it hardly seems wise to show a popular audience reproductions of pathologic specimens, such as decayed lungs, etc.

No public lecture on tuberculosis is ever complete or will ever fulfill its mission without an ardent remonstrance against phthisiophobia—that insane, exaggerated fear of the presence of consumptives as such. In the chapter on individual prophylaxis, Dr. Baldwin has explained the simple measures by which the consumptive may protect others from infection and himself from reinfection, thus plainly showing the folly of individual phthisiophobia. In a popular lecture it should be declared emphatically that the clean, conscientious consumptive who takes

care of his expectoration is no more a source of danger to his fellow men than any healthy citizen.

Unjustified Prejudice against Consumptives.—But besides this individual fear of the presence of the consumptive on account of his disease, there is another prejudice based on his alleged different and peculiar mentality. People forget that among the consumptive invalids of the past and the present there have been and are some of the best types of manhood and womanhood—useful, noble, and valuable citizens, humanitarians, scientists, and philanthropists. The idea prevails among lay people, and now and then even among medical men, that the average pulmonary invalid is mentally and morally inferior to the average healthy individual or one afflicted with some other infirmity.

A few years ago, when preparing an address entitled "A Plea for Justice to the Consumptive," which was read before the New York Society of Medical Jurisprudence, as a reply to recent attempts to discriminate against the consumptive, the writer solicited the opinions of leading medical authorities on this subject, which served well as a rebuke to those daring to make the statement that because an individual is tuberculous he is, therefore, mentally unsound or more inclined to immorality and selfishness than any other individual.

One of these authorities, Dr. E. L. Trudeau, says:

> I have never noticed any greater tendency to immorality or crime among consumptives than is to be found in the average of the human race, as far as it has come under my observation. On the contrary, I have seen all the finer traits of the human nature developed to the fullest extent by the burdens which chronic and fatal illness, often slow in its progress, adds to the sum total of what men and women usually have to endure in life. I have seen certainly more patience, courage, self-denial, and unselfish devotion to others in consumptives than I have noticed in the majority of healthy human beings. Indeed, the sanatorium work never could have been carried on were it not for the self-sacrificing devotion to the suffering of others shown by my associates, the nurses, and even the employees at the sanatorium, most of them having come here originally because suffering from tuberculous disease. History is full of instances which prove that tuberculosis does not interfere with the development to the highest degree of the intellectual, the moral, or the ethical sides of man's nature.

It would hardly seem necessary, after such opinions expressed, for the writer to add his own opinion, though based on an experience of many years of practice among consumptives in different climes and different countries, and among men and women in all stations of life. The writer has not only practiced, but also lived among them and with them, and from all his experience he can only confirm what has been said by others. Never has he noticed consumptives to be more inclined to

immorality or crime than individuals afflicted with other diseases, or even well people; in only a few instances has he noticed real selfishness, and never what one could call a distortion of the clearness of ethical perception. On the contrary, as in the experience of Drs. Osler, Janeway, Trudeau, and Bowditch, it has always seemed to him that many consumptives are above the average in their mental and moral characteristics. Instead of brute selfishness, the writer has frequently witnessed the most touching evidences of self-sacrifice and devotion. He has seen colleagues in institutional and private practice, trained nurses and sisters of charity, who, though they knew they had contracted tuberculosis in the pursuit of their professional duties, did not leave the battlefield, but continued to labor and help their consumptive fellow-sufferers. Two of the writer's most beloved teachers, to whom he owes an everlasting debt of gratitude for the inspiration and help they have given him in his work, Professor Grancher, of Paris, and Geheimrath Dettweiler, of Falkenstein, were both consumptives. They taught and practiced among consumptives for a quarter of a century, and were leaders in the antituberculosis crusade in Europe until the very last days of their lives. Dr. Dettweiler died in 1904 and Professor Grancher in 1907.

Among the sweetest experiences and recollections of his life, the writer will always count the gratitude of the consumptive, poor or rich, expressed either on the assurance of their recovery or for the care bestowed on them when their case was beyond human help.

Federal Phthisiophobia.—Occasionally, besides a private or individual phthisiophobia, there exists also what may justly be called an official phthisiophobia. It is manifested, for example, in efforts to exclude consumptive individuals from certain states or countries, or in hindering efforts to build sanatoria and special hospitals.

While the practice of getting rid of the consumptive poor in one locality by sending them to other States is contemptible and should be unlawful, it must be considered cruel and inhumane to exclude from any state or country the well-to-do tuberculous invalid who is willing to obey all the sanitary regulations which will make him no longer a source of danger. Equally inhumane and unwise are any laws and regulations that make the establishment of institutions difficult, as, for example, the law, known as the Goodsell-Bedell law, which was signed by Governor Odell, the then governor of the State of New York. The subject of official phthisiophobia is such an important one to all physicians and public-spirited citizens interested in the crusade against tuberculosis, that in dealing with it the writer feels justified in reproducing in substance what he said on the subject in the above-mentioned address, entitled "A Plea for Justice to the Consumptive."

Official phthisiophobia started in the United States about two years ago, when the Surgeon-General of the Public Health and Marine Hospital Service issued a declaration that pulmonary tuberculosis must be classed as a dangerous contagious disease, and that in future immigrants or aliens visiting our shores afflicted with pulmonary tuberculosis must be debarred from all ports of the United States. In June, 1907, an order was issued confirming the above decision, and adding that tuberculous individuals should be debarred, regardless of boards of special inquiry which heretofore had used their discretion in the matter.

It goes without saying that no one desires pauper immigration, and that no one wants any such class to enter the country, whether they are tuberculous or not. The question here is simply, Is it right, just, and scientific to declare pulmonary tuberculosis a dangerous, contagious disease, and exclude on that account worthy immigrants who offer a guarantee that they will not become a burden to the community, or to exclude aliens or visitors afflicted with pulmonary tuberculosis? Have those who have been instrumental in bringing about the government decision to declare pulmonary tuberculosis a dangerous, contagious disease, or who favor this decision, ever thought of the fearful meaning of a designation which virtually classes every American consumptive with patients who may be suffering from small-pox, leprosy, yellow fever, etc.? Have they ever thought how really few families there are who have not at least one more or less near relative or friend who is a consumptive? Tuberculosis is the most common of all diseases, and it is most prevalent in the pulmonary form. It is a disease of the young and old, of the poor and rich, the East and the West, the North and the South.

The following resolutions represent the consensus of opinion of the medical profession on this subject presented to the New York Academy of Medicine at the time, and which were seconded by Prof. Edward G. Janeway, of that city, and adopted by the Academy at its regular meeting on February 6, 1908:

Whereas, The Treasury Department of the United States, upon recommendation of the Surgeon-General of the Marine Hospital Service, has recently decided to classify pulmonary tuberculosis with dangerous contagious diseases, Be it

Resolved, That the New York Academy of Medicine deeply deplores this decision, which is not based on either clinical experience or on scientific experiments. Be it further

Resolved, That the Academy considers the exclusion of nonpauper tuberculous immigrants and consumptive aliens visiting our shores unwise, inhumane, and contrary to the dictates of justice. Be it further

Resolved, That while the Academy is convinced of the communicability of tuberculosis and urges all possible precautions against the spread of the disease occasioned by sputum and tuberculous food, the Academy is opposed to all measures by which needless hardship is imposed upon the consumptive individual, his family, and his physician.

The secretary of the Academy was instructed to forward a copy of the resolutions to the Treasury Department, the Surgeon-General of the Marine Hospital Service, and to the secretary of the New York State Medical Society.

Among the many distinguished men who helped in the support of these resolutions are the following: Prof. Hermann M. Biggs; Prof. T. Mitchell Prudden; Prof. George M. Peabody; Dr. A. H. Doty, the Health Officer of the Port of New York; Dr. August J. Lartigau, of the Bacteriological Department of Columbia University; Dr. George B. Fowler, ex-president of the New York County Medical Society; Dr. George F. Shrady, editor of the *Medical Record*; Dr. Andrew H. Smith, the then president of the New York Academy of Medicine; and Dr. Frank P. Foster, editor of the *New York Medical Journal*.

Of leading editorials which appeared at the time in American medical journals, the following are good examples: Dr. George M. Gould, editor of *American Medicine*, said: "We think professional and lay opinion will not justify the exclusion of tuberculous immigrants on the simple ground that the disease is 'contagious' or 'communicable.' It is only so in such a low degree that the severe measure of expulsion for this reason alone seems unjustifiable." Dr. George H. Simmons, editor of the *Journal of the American Medical Association*, the representative organ of the American medical profession, says in regard to the resolutions: "The resolutions presented to the Academy of Medicine are to the point and express the opinion, I believe, of about ninety per cent of the best men in the profession who have given thought to the subject." Dr. U. O. B. Wingate, secretary of the Wisconsin State Board of Health, expressed himself regarding this matter as follows: "The action of the head of the Marine Hospital Service in this matter is simply inhuman."

To the best of the writer's knowledge, this almost universal protest on the part of the medical profession of this country regarding the decision of the surgeon-general, acting under the authority of the Treasury Department, has to this date remained unheeded.

State Phthisiophobia—Goodsell-Bedell Law.—Before showing the results of federal official phthisiophobia on the general public, let us consider state phthisiophobia. The writer does not wish to arraign the attempts of certain California and Colorado statesmen to exclude

phthisical invalids from their borders, but will confine himself to the State of New York. Mr. Benjamin B. Odell, Jr., at that time (1903) governor of this State, by signing the Goodsell-Bedell bill already referred to, put himself on record as favoring official phthisiophobia.

Under the law of 1900, chapter 327, cities of the first class were authorized to erect sanatoria for the treatment of consumptives outside the city limits, such acts and the selection of the site to be subject to the approval of the State and local boards of health. Private property was sufficiently protected by the general laws. The effect of the Goodsell-Bedell law is to make it hereafter practically prohibitive to establish such a sanatorium anywhere in the State. If any board of supervisors of a county or a town board should be opposed to the establishment of an institution for consumptives, the mere adoption of resolutions would suffice to make the erection of such an institution impossible.

The governor was implored from all sides not to sign the bill. The New York Academy of Medicine protested, as it usually does when there is danger to the public health and welfare from injudicious legislation, and passed the following resolutions on the subject:

Whereas, There has been recently passed by the Legislature of the State of New York an act to amend the public health law in relation to the establishment of public sanatoria, hospitals, or camps for the treatment of tuberculosis, which act reads as follows: "A hospital, camp, or other establishment for the treatment of patients suffering from the disease known as pulmonary tuberculosis shall not be established in any town by any person, association, corporation, or municipality, unless the Board of Supervisors of the County and the town board of the town shall each adopt a resolution authorizing the establishment thereof, and describing the limits of the locality in which the same may be established;" and

Whereas, The effect of this bill, if it becomes a law, will make it impossible for any city in the State, or any fraternal order, charitable society, or philanthropic individual, to establish a hospital, camp, or other establishment for the treatment of consumptives, outside of the city limits, except under conditions which are practically prohibitive; and

Whereas, By chapter 327, of the laws of 1900, cities of the first class are authorized to erect sanatoria outside of the city limits, such action and the selection of a site to be subject to the approval of the State Board of Health, and by the same law, hospitals and institutions, now or hereafter established or maintained, are made subject to the approval of the local board of health; and

Whereas, Private property rights are sufficiently protected by general laws, and the process of injunction is open, in case it can be positively shown that unwarranted injury would be inflicted by the establishment of a hospital on a particular site, and the necessity of obtaining the consent of the State Board of Health being an ample guarantee that a site shall not

be selected which shall threaten or unduly expose the health of any particular neighborhood; and

Whereas, It has been demonstrated in this country and in Europe that properly conducted sanatoria, hospitals, and camps for consumptives are not a danger to the neighborhood, and that such institutions are places where the consumptive poor receive a hygienic education, and have the best possible chances to be cured and become again useful citizens and supporters of families; and

Whereas, There is at present a great deficiency of hospital accommodation in New York State for this class of patients; Be it therefore

Resolved, That the New York Academy of Medicine deeply deplores the passage of the above bill, and urgently requests his Excellency the Governor to withold his signature to the act, which, in case it became a law, would involve the loss of thousands of lives and increase the spread of tuberculosis within the crowded districts of our cities and towns, and would have to be considered an act of the greatest injustice and inhumanity.

In commenting on the governor's apology for signing this bill in spite of the many protests, the editor of *Charities*, the organ of the New York Charity Organization Society, says: "All that we can say is that undue consideration seems to us to have been given to the 'property interests' to which the governor refers and none at all to the consumptives, of whom some 20,000 will die of their disease in the State of New York this year." Up to the present time (1909) the Goodsell-Bedell law still stands unrepealed.

Results of Federal and State Phthisiophobia.—What has been the result of this Federal and State phthisiophobia on smaller authorities, such as municipal, town, and village boards? Municipalities, situated in particularly healthful regions, which formerly allowed their unsupervised boarding houses to be crowded with consumptives, which was unsafe and unwise, have gone now to the other extreme, prohibiting the establishment or the existence of well-conducted sanatoria in their neighborhoods. Yet it is known to all that there is not the slightest danger from well-conducted sanatoria; they are, on the contrary, veritable schools of hygiene, exerting a most beneficial influence by educating the people at large in preventive measures.

As soon as town or village boards learn that the establishment of a sanatorium is contemplated in the vicinity of their respective communities, they come together and oppose every movement favoring such a plan. Those who are occasionally asked to help in selecting a site for a sanatorium for consumptives will affirm that at the present time there is nothing more difficult in New York State than to find a community which would welcome the establishment of such an institution. The small municipalities, the towns and villages, are now strengthened

in this insane prejudice by the Goodsell-Bedell law. Yet, as it has been proved again and again by most reliable statistics, instead of being a danger, sanatoria for consumptives are a blessing to the neighborhood. In the two German villages Goerbersdorf and Falkenstein, where five of the most flourishing sanatoria for consumptives have been in existence for the last fifty years, the mortality from tuberculosis among the inhabitants of the respective villages has decreased by one third from what it was before the establishment of these institutions. This remarkable result is simply due to the fact that the villagers voluntarily imitate the hygienic precautions which are obligatory on the inmates of the sanatoria.

Again, the well-known fact that in carefully conducted and well-equipped sanatoria, where the precautions concerning the sputum are most strictly adhered to, one is safer from contracting tuberculosis than perhaps anywhere else, should open the eyes of these narrow-minded village authorities.

There is an urgent and crying need for more sanatoria for the treatment of tuberculous patients, and the sooner restrictive laws, such as the Goodsell-Bedell law, are repealed the better it will be for the financial as well as the sanitary conditions of the very communities which are now opposing the establishment of such institutions. These sanatoria educate and cure at the same time; they cure the curable, and when patients are sent there at the right time they have at least seventy-five per cent of chances of being cured, often in less than a year's time. Not treated and not cured, they will cease to become breadwinners, and linger often as burdens to the community for one or two years.

Law of New Mexico as a Contrast to the Goodsell-Bedell Law.—Of historic interest and in pleasant contrast to the enactment of the Goodsell-Bedell law, is the law of New Mexico of 1903, chapter xvii, which provides that any company or corporation which shall, within one year from the passage of this act, commence and within two years after the passage of this act shall have expended at least $100,000 in the construction of a sanatorium in New Mexico for the care of invalids and persons with tuberculosis and other pulmonary diseases, shall thereafter be exempt from taxation on all property actually used in connection with such sanatorium for a period of six years after the expiration of two years after the passage of this act.

It is always wise for the chairman of a public meeting, or for the lecturer himself, to tell the audience that they are permitted to ask a limited number of questions to elucidate points which may not have been understood. But almost invariably at the conclusion of such a lecture a number of the audience will embrace the opportunity to ask the lecturer for some definite advice concerning their own or some one

else's ailment. There is but one answer which a conscientious physician can give under such circumstances, and that is: "I am here as a general adviser and not as an individual physician to be consulted for individual ailments. You must seek medical advice where it is always to be found—in the office of the physician. Tell your troubles to your own physician, and he will best know whether additional counsel is needed or not."

Journals Devoted to the Prevention of Tuberculosis.—Persons in the audience will often ask the lecturer what they should read in order to keep posted on things concerning tuberculosis. There are three journals published in the United States which are admirably adapted to this purpose: *The Journal of Outdoor Life* (Trudeau, N. Y.), *The Survey,* formerly *Charities and the Commons* (105 East Twenty-second Street, New York, and "The Rookery," Room 616, Chicago), and *The Open-Air Quarterly* (Concord, N. H.).

The number of lectures which should be delivered depends, of course, on the size of the community and on the other opportunities for educating the public. Thus, for example, owing to the traveling tuberculosis exhibit of last year there were exceptional occasions for unusual activity on the part of the New York Committee. During one year in New York City (1906) there were delivered under the auspices of the Board of Education, Department of Public Lectures, 35 evening lectures to adults in the various public-school buildings of Greater New York; and under the auspices of the Tuberculosis Committee there were delivered 54 lectures in churches, clubs, lodges, settlements, etc., and 59 before labor unions; 280 lectures were delivered to school children, with an attendance of 105,000. These lectures to children, and many delivered before clubs, settlements, and labor unions, were in connection with the traveling exhibit. In view of the fact that tuberculosis is so very prevalent among the laboring population, the coöperation of a tuberculosis committee with such unions is particularly to be recommended, for it cannot help but lead to good results. The vast importance of educating the children in the prevention of tuberculosis is self-evident and needs no further comment.[1]

The Public Press and Tuberculosis.—The public press is a most powerful factor in the dissemination of knowledge concerning the prevention of tuberculosis. However, to avoid sensational and inaccurate

[1] An interesting and novel method of educating the public visiting a tuberculosis exhibition was inaugurated by the New York State Department of Health. A large phonograph for which a well-trained voice had given a record embodying a short, concise and comprehensive popular lecture, was put in motion at certain intervals. The people usually gathered around and listened attentively to what the phonograph had to say.

accounts or misrepresentations of what the lecturer has said, it is advisable to have a statement carefully prepared for the press to be given to the reporters who may be present at the lecture.

Next to the press the clergy can certainly do much to help the medical profession in the crusade against tuberculosis. The clergymen of all denominations should see to it that their churches are hygienically constructed and well ventilated. Fixed carpets should not be used in places of worship where so many people congregate. Catholic priests in charge of large congregations may do well to follow the example of a great Roman divine, the Bishop of Fano, in Italy. In a circular recently issued by him, he asks the priests of his diocese to comply with the following rules:

(1) In every church the floors must be regularly cleaned with sawdust, saturated with a strong sublimate solution. This thorough cleaning should take place particularly after holidays when great masses of people have visited the church.

(2) Every week all ordinary chairs and confessional chairs must be thoroughly cleaned with moist rags.

(3) The grate of the confessional chairs must be washed every week with lye and then polished.

It might be of advantage if such articles of adoration as crosses, statues, or, as in Greek churches, pictures which are often kissed by devout people, be included in the periodical disinfection. Kissing the Bible when taking an oath should be discouraged by jurists and divines.

Some ministers may not feel that they have either the knowledge, the ability, or the inclination to deliver a lecture or sermon on the prevention of tuberculosis. In such a case they will do well occasionally to invite a physician to occupy the pulpit, as was done recently in Rochester, N. Y., to preach a dignified sermon which will arouse the people to an interest in the antituberculosis crusade and help them to see their duty toward the poor consumptive who is their fellow man.

Tuberculosis Exhibits, etc.—Tuberculosis exhibits are most important factors in the education of the public concerning this disease. They should be objective presentations of the history, distribution, varieties, causes, cost, prevention, and cure of tuberculosis. This means models, photographs, charts, diagrams, circulars, etc., whereby hygienic and unhygienic methods of living, proper and improper care of consumptives, are graphically shown. Besides the evening lecture, which should always be a feature of a tuberculosis exhibition, there should be a person in constant attendance, able to explain and give information to the visitors. Children from ten years upward should be given admittance to the exposition as well as adults. The accompanying illustrations of parts

of the exhibits of the last International Congress ('08) (see Figs. 128 to 130) give a good idea of the appearance of such an exhibition. This exhibit was shown in New York.

To show the composition, scope, and result of such a traveling exhibit, the writer may be permitted to quote from the above-mentioned report, submitted by the secretary, Mr. Paul Kennaday:

The effectiveness of the tuberculosis exhibition has been in the nature of a discovery. This has been so with others, who in many widely scattered parts of the country have shown the exhibition of the National Association, and most assuredly has it been true in New York City. It seems

FIG. 128.—EXHIBITION OF INTERNATIONAL TUBERCULOSIS CONGRESS, 1908. (Transferred to New York.)

more than probable that it is a plan of operation that has come to stay and to spread; it may, therefore, serve a useful purpose, if there is here given some detailed account of the manner in which these Committee exhibitions were handled.

The Committee's Traveling Tuberculosis Exhibition is made up of 249 frames of photographs, charts, etc., 13 models, and 10 pathologic specimens, all divided into three classes, as shown more particularly by the four-page programmes which are liberally distributed at all the exhibition halls. The first division reads, "Tuberculosis is a preventable disease," and here are the principal part of the Board of Health exhibits: A large chart showing the reduction of the death-rate from tuberculosis in New York City from 4.92 in 1881 to 2.66 in 1905, a series of printed instructions for consumptives and those living with them, and diagrams and photographs illustrating generally the educational and preventive work carried on by

the department. The work of the National Consumers' League, of the City Tenement House Department, the State Factory Department, and of the

FIG. 129.—EXHIBITION OF INTERNATIONAL TUBERCULOSIS CONGRESS, 1908.

Tenement House Committee and the Committee on the Prevention of Tuberculosis of the Charity Organization Society, are shown here by models, photographs, diagrams, etc.

FIG. 130.—EXHIBITION OF INTERNATIONAL TUBERCULOSIS CONGRESS, 1908.

Perhaps most striking of the exhibits in this section, if not in the whole exhibition, are the full-size models of a dark interior bedroom, dirty

and crowded with furniture, typical of the rooms in which many a poor man develops tuberculosis, and the adjoining front room with open windows and clean cot, spread with blankets between which have been sewed newspapers as a cheap and at the same time warm covering, representing the changes wrought by visiting nurses and charity visitors.

Under the second division, "Tuberculosis is a communicable disease," is a collection of nine human lungs, presenting the healthy lung, the normal city lung pretty well spotted with dust and dirt, and lungs showing the process of healing and in various stages of disease. As a part of the pathologic exhibit, and placed around these specimens of lungs, are the Board of Health signs prohibiting spitting, diagrams and photographs illustrating the methods of infection through spitting and coughing, and an exhibit of dry brooms, feather dusters, wet paper, moist sawdust, etc., illustrating the right and wrong way to sweep and clean. To still further enforce the practical value of this division of the exhibition, there are distributed at this point simple instructions in relation to sweeping and dusting, printed on small cardboards in English on one side and on the reverse side in Yiddish, Italian, German, and Bohemian.

The third and last division of the exhibits is, "Tuberculosis is a curable disease," under which comes the illustration by means of photographs and models of the work of all of the city tuberculosis hospitals and special tuberculosis dispensaries. Here, in the same way, are shown models of the Sea Breeze Hospital for Children, of the lean-tos from Loomis Sanatorium, of the White Haven shacks, and photographs from the Adirondack Cottage Sanatorium, from the Boston Day Camp, and from a number of other places outside of New York City. The exhibits are all labeled, and throughout there is the attempt to make the lesson so plain that it will be readily understood by all, while lectures and demonstrations alike try to translate for the practical application of the average man the graphic representation of tuberculosis, preventable, communicable, and curable.

With the amount of material that is shown, ease and rapidity of installation is all important, and, therefore, models, picture frames, and cases are all so made that they may be handled with the least possible delay and without unnecessary labor. For the setting up of the exhibits, taking from two to three days, is but a small part of the work necessary in connection with each exhibition. After the arrangement of the definite preliminary itinerary, the substitution of other exhibition places for those which have dropped out, and perhaps the complete rearrangement of the whole schedule, it is time to hold a series of conferences, about a month in advance of each exhibition, when the coöperation is sought of the local physicians, settlement workers, school teachers, clergymen, and generally all those who are identified with the social work of the particular neighborhood in which the exhibition is to be held; after this, a schedule is arranged for the attendance from ten o'clock in the morning until ten o'clock in the evening of persons competent to explain, in turn, to small groups of people the meaning of the different exhibits and the purpose of the exhibition—physicians and nurses are usually asked to do this part of the work, those

from the region in which the exhibition is to be held being called on as far as possible, each member of the group selected for demonstration for each exhibition being asked to volunteer for three periods of two hours each. The Board of Health, realizing the large possibilities of these exhibitions, in addition to loaning much exhibition material and department wagons for moving the exhibition from place to place, regularly assigned two physicians for the daily instruction of the school children, and thus the task was much lightened of obtaining volunteer instructors in sufficient number to be on hand eight and more hours a day for an almost unbroken period of five months.

On the whole, the attendance at these exhibitions has been most satisfactory, running from about 3,000 in the smaller halls to 49,000 in three weeks at the Educational Alliance, a large Hebrew educational and social betterment institution in the congested lower East side of the city. In five months there has been a total attendance of over 82,000 persons.

The most promising single feature of the scheme has been the intelligent interest shown by the children of twelve years of age and upward who, under arrangement with the Department of Education, have been sent to the exhibitions in charge of their teachers by their local principals as a regular part of their school work. For the instruction of these children the Department of Health has regularly assigned a Department Inspector, Dr. Anna C. Judkins, who in a plain, simple, and practical manner explained the exhibits to the children and answered their many questions.

While speaking of tuberculosis exhibitions, it is but right to mention one of the latest features in the line of pictorial demonstrations of value in the antituberculosis crusade—the open-air lantern exhibit, which originated with Dr. Oscar H. Rogers, of Yonkers. The New York Health Department made immediate use of Dr. Rogers's admirable suggestions. Thus, during last summer, in twenty-five of the small parks of the city, and at five recreation piers on the river fronts, there were shown, before crowds varying in numbers from several hundred to two or three thousand, a set of stereopticon slides giving in short sentences easily understood advice in relation to tuberculosis. Along with these sentences pictures were thrown on the screen which showed the ways in which the bacilli causing tuberculosis are transmitted by the cough and expectoration of those who have it, by dust and air filled with particles of dried sputum. They showed the effect of the disease on the lungs; how overcrowded, dirty, badly ventilated rooms and tenements cause and spread it; how these conditions are being remedied by new building laws; how the Department of Health renovates rooms infected with the germs of consumption by fumigation and the removal and disinfection of bedding and furnishings; how it cares for patients in the Riverside Hospital; and finally the possibility of arresting and curing

many cases in country sanatoria, such as that recently opened by the Department at Otisville, Orange County, N. Y.

In Dr. Rogers's excellent paper, "A Working Programme for a Small City," read at the third annual meeting of the National Association at Washington (1907), he gives a list of illustrations of which he made use in his public propaganda with the open-air lantern exhibit. They comprise twenty-one graphic illustrations suitable for any city, and were shown in the following order:

1. Plan of a street in Yonkers showing infected houses (similar to the "Lung Block" sketched in the "Handbook on the Prevention of Tuberculosis").
2. Plan of another street in a different part of the city.
3. A graphic illustration of the mortality among people of various nationalities.
4. A graphic illustration of the mortality in various occupations.
5. A photograph of tubercle bacilli.
6. Section of normal lung showing air vesicles.
7. Section of diseased lung showing tubercles.
8. A crude sketch showing infection through spitting. This effective drawing was borrowed from the tuberculosis exhibit and is one of the strongest arguments so far devised. In our lectures we speak of the spitter as the "murderer."
9. The same sketch showing infection through coughing. This came from the same source.
10. Photograph of a gelatin plate infected by a fly which had just been walking in tuberculous spit.
11. A gelatin plate infected by tubercles expelled by a tuberculous patient in the act of coughing.
12. Photographs of various spitcups.
13. Dark, close room in tenement, showing lounge on which a consumptive lay dying.
14. Same tenement, with lounge near an open window and arranged by visiting nurse—an effective illustration of the value of the visiting nurse.

15 and 16. Home treatment on fire escape.

17. Home treatment on roof of tenement house.
18. Window tent for use in home treatment.
19. Shack treatment as carried on at Liberty, N. Y.
20. Shack treatment as carried on at Ward's Island.
21. Model of inexpensive shack.

As a further help to those who wish to follow this method of reaching people with the antituberculosis propaganda, Mr. Kennaday, in his admirable report, gives in full the sentences that have been used with success, with the perhaps obvious warning that in preparing slides for

this purpose the shorter the sentences the better, and that the letters should be large, heavy, and thick, so as to be easily legible at some distance on an eighteen-foot screen, a size that has been found serviceable. These sentences will be found reproduced in the Appendix.

As a novel means to bring the gospel of the prevention of tuberculosis to the masses, and particularly to the workers in great factories, we must not fail to mention the following ingenious method: An itinerant tuberculosis exposition was recently organized under the auspices of the Kensington Tuberculosis Dispensary of Philadelphia and the Kensington branch of the Y. M. C. A. During the noon hour a course of lectures was delivered to the mill workers in the northeastern district of Philadelphia from a wagon fitted with a suitable exhibit to illustrate the points made by the speakers.

Books and popular essays, pamphlets and circulars, intended to enlighten the public on the subject of tuberculosis should be concise, avoiding technicalities and scientific phrases. An attempt to incorporate all these essentials in compact form has been made by the writer in a little essay entitled "Tuberculosis as a Disease of the Masses and How to Combat it" (Knopf, '07). But for large and general distribution such a pamphlet, for example, as that issued by the New York City Health Department is perhaps best fitted for the purpose (see Appendix).

If the population for which the circulars are intended is presumably not able to read English, it is of course essential that the example of the New York Health Department should be followed, which has its popular circulars translated into such languages as Bohemian, Chinese, German, Hebrew, Hungarian, Italian, Polish, Ruthenian, Russian, etc. To encourage the foreign population within the borders of the United States to study the health regulations in the language of their adopted country, it may also be well to follow the example of the New York Health Department and print the circular in English on one side of the page and in the language of a respective foreign country on the other.

A school circular, or catechism, which was recently issued by the New York Board of Health, may also serve as a model for educating the rising population in the simple methods of the prevention of tuberculosis. Of this catechism about 700,000 copies have been printed and distributed for the use of school children throughout all the public schools of the city of New York. A small leaflet taken from the chapter on "School Hygiene" in the essay referred to may, perhaps, also be helpful as the A B C in the education of younger children.

A valuable pamphlet on "The Opportunity and the Responsibility of the Teacher in the Prevention of Tuberculosis" has been issued by the

Tuberculosis Committee of the Charity Organization Society, having the following subtitles: The Cause of Tuberculosis; The Germ of Tuberculosis; What Protects Against Inhaled Germs; The Development of the Tubercle Bacillus; Tuberculosis is Not a Contagious Disease; Tuberculosis is Not Inherited; The Methods of Prevention; Spitting; Cleaning; The

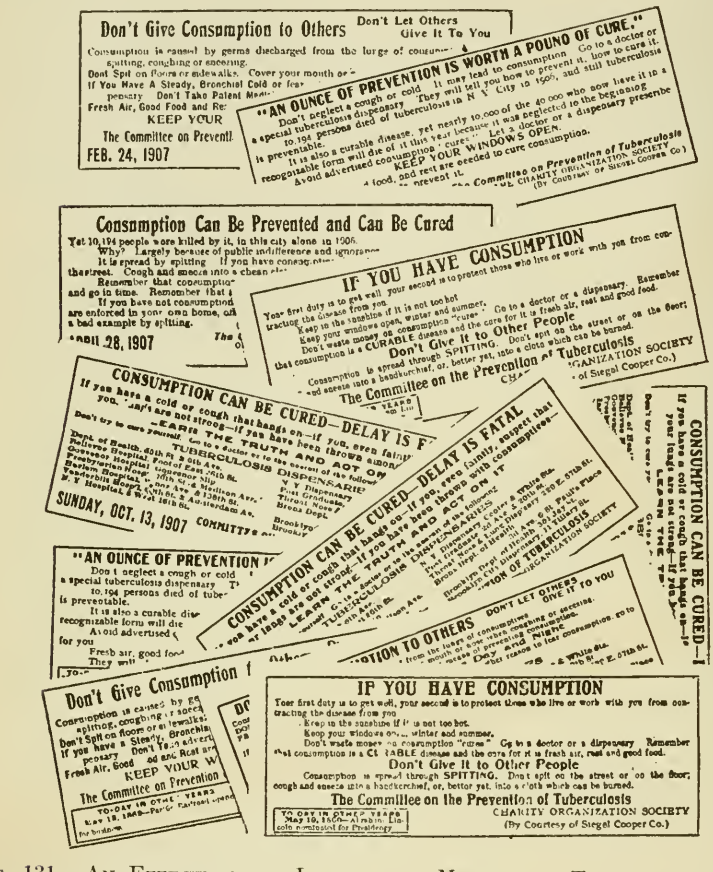

FIG. 131.—AN EFFECTIVE AND INEXPENSIVE METHOD OF TUBERCULOSIS PROPAGANDA. Free advertisements of New York Tuberculosis Committee on back of street-car transfers.

Duty of Consumptives; Tuberculosis is Curable; Administrative Control; The Department of Health; The Department of Public Charities; Bellevue and Allied Hospitals; The Tenement House Department; Other Administrative Activities; Dispensaries; Sanatoria and Other Private Agencies.

In order that the patient may choose for his dispensary the institution nearest his home, a map of the Manhattan districts, with Roman

letters showing the locality of the dispensaries and hours when they are open, is reproduced on the last page of these circulars.

A unique way of spreading the knowledge concerning the prevention of tuberculosis is to utilize the back of street-car transfers (see Fig. 131).

Circulars of information may have to be varied to suit the locality in which they are to be distributed, and the people to whom they are to serve as guides, and the circulars and leaflets given in the Appendix are by no means expected to suit all purposes, all classes, nor all communities.

From a circular intended for physicians only, which was recently issued by the New York City Health Department on the subject of bacteriologic examination of sputum, are quoted the following conclusions which may prove helpful in the crusade as far as the profession is concerned:

First. Incipient tuberculosis tends to recovery.

Second. Advanced tuberculosis, with or without mixed infection, tends to a fatal issue.

Third. In all coughs which last more than a few weeks, and which are not associated with asthma, emphysema, or cardiac disease, tuberculosis is to be suspected as a cause.

Fourth. Successful treatment and prophylaxis demand the earliest possible diagnosis.

Fifth. The diagnosis of incipient pulmonary tuberculosis, properly so called, is made positive when tubercle bacilli are found in the expectoration.

Sixth. Repeated examinations of the expectoration are frequently necessary to demonstrate the presence of the tubercle bacilli in incipient cases of pulmonary tuberculosis.

In order that bacteriological examinations of the sputa may be at the service of the physicians in all cases, the Health Department is prepared to make such examinations, if samples of the sputa, freshly discharged, are furnished in clean, wide-necked, tightly stoppered bottles, accompanied by the name, age, sex, and address of the patient, duration of the disease, and the name and address of the attending physician.[1]

Tuberculosis Clinic.—In the larger centers of population, in fact, perhaps, in all larger communities where there are a considerable number of poor or relatively poor people, the tuberculosis dispensary, or at least a special tuberculosis class in an ordinary dispensary, is one of the most important factors in the crusade against tuberculosis.

[1] I have found Dr. Hart's improved wooden box with a dark impermeable lining the most suitable for sending sputum specimens to the laboratory for examination. (See Appendix.)

The object and purpose of a *tuberculosis clinic*, as it has been set forth in the first report of the Clinic for Pulmonary Diseases of the Health Department of the City of New York, may be set forth as follows:

It was early recognized that the establishment of a municipal clinic or dispensary would be of great assistance in the attainment of the following desired objects:

1. *The Early Recognition and Accurate Diagnosis of Pulmonary Tuberculosis.*—It is now generally admitted that tuberculosis is frequently a curable disease, and that incipient tuberculosis, under favorable conditions, tends to recovery; but to insure such recovery the diagnosis must be made at the earliest possible moment. Not only should careful physical examinations be made, together with repeated sputum examinations, as required in connection with the clinical history, but in addition, when necessary, the tuberculin test, Roentgen-ray examinations, and radiography should be employed to assist in arriving at an early and correct diagnosis.

2. *The Intelligent Supervision of Patients under Treatment.*—This supervision should include not only hygienic and medical treatment, but also the furnishing of circulars of information in various languages (English, German, Yiddish, Italian, Chinese, Ruthenian, Polish, Hungarian, and Russian), containing information as to the nature of the disease, and careful instructions as to the precautions necessary to be taken to prevent the infection of others. Paper sputum cups, paper handkerchiefs, and proper food (milk and eggs) should be supplied to indigent and needy cases.

3. *The Continued Observation of the Homes of Indigent, Needy, and Ambulant Cases, Including all those Discharged from the Public Institutions of the City.*—A special staff of trained nurses should visit the patients at their homes to see that the instructions given are observed, that the sanitary surroundings are satisfactory, and to afford such assistance as is required. Suitable cases should be referred to the various charitable organizations for food, fuel, ice, etc. Special attention should be paid to the children in the families of tuberculous persons, and every effort made to prevent their infection.

4. *The Removal of Cases Requiring such Care to Hospitals or Sanatoria.*—These cases fall under four heads: (*a*) Advanced or bedridden consumptives, with profuse expectoration, who will not or cannot take the necessary precautions against spreading the disease, and whose presence at home is a menace to others in the family; (*b*) consumptives who are able to get about, but who are unable to work and are entirely dependent upon their earnings for their livelihood; (*c*) incipient cases, who stand a good chance of recovery if removed to sanatoria outside of the city; (*d*) consumptives living in lodging houses and those having no home.

5. *The Provision of a Municipal Institution to which Cases of Tuberculosis may be Referred.*—(*a*) By physicians (indigent patients, etc.); (*b*) by institutions (on the discharge of consumptive patients from hospitals or sanatoria); (*c*) by the various charitable organizations through-

out the city which keep tuberculous cases under observation; (*d*) by other persons doing individual charitable work who may come in contact with such persons; and (*e*) by other city departments.

6. *The Extension and Strengthening of the Sanitary Control of Tuberculosis among the Poor by the Department of Health.*

7. *The Care of Laryngeal Cases.*—The involvement of the larynx is one of the saddest complications of pulmonary tuberculosis, and the pain, distress, and discomfort of the patients are great. While the prognosis in these cases is extremely grave, yet under proper treatment recovery takes place in some instances, and in most the distress of the patient can, in some degree at least, be relieved. Special attention should be paid to such cases in a fully equipped throat clinic.

In a city like New York, where ground is expensive, it is often difficult to procure the desired plot for the erection of a municipal building, particularly for the purpose of treating tuberculosis. One has, then, to contend with the objection of neighbors guided by selfish motives, by phthisiophobia, fear of depreciation of value of neighboring property, etc. The ideal dispensary should be placed on elevated ground, in a locality where there is relatively little traffic, yet easy of access, and where the air is as pure as can be found within the city limits. Not all such ideal conditions existed when the New York Health Department decided, in 1903, to establish its first municipal tuberculosis dispensary. For obvious reasons, the name "Clinic for Communicable Pulmonary Diseases" was decided on. The lot being narrow and between high structures, and all the available ground space being required, windows could only be had on the ends. The building (Fig. 132) was therefore limited in height to one story, with a cellar below, in order that each room could be lighted by a ventilating skylight. To insure further ventilation, square openings were cut high up in the walls of the various rooms, connecting them with each other and with the halls, and electric fans were installed in suitable places.

Fig. 132.—Exterior of Tuberculosis Clinic of New York Health Department at 965 Sixth Avenue.

As will be seen in the plan (Fig. 133), the subdivisions are as follows: (1) Entrance; (2) registration room in which all applicants are received, their history taken, and all records filed; (3 and 4) waiting rooms for male and female patients, each with its toilet; (5 and 6) dressing rooms for physicians and nurses, each containing a closet for cloths,

a washstand, and toilet; (7) throat clinic, with complete outfit, including compressed-air-spray apparatus, electric sterilizer for instruments, instrument cabinet, and a full stock of all necessary instruments and apparatus; (8) Roentgen-ray room, the equipment of which consists of a twelve-inch coil, with electrolytic breaks and microrheostatic control, Crooke's tubes of several patterns and sizes, fluoroscopes (15×18 inches), tube stands, examination table, supply and apparatus cabinet, etc.; (a dark room for the immediate development of radiographic plates is being constructed in the basement of the clinic, beneath the X-ray room); (9 and 10, 11 and 12) male and female examination and patients' dressing rooms, containing desks, stools, etc., also a pneumatic cabinet for compressed- or rarefied-air treatment; and (13) drug room, containing in enameled metal cabinets a full supply of all medicines furnished by the drug laboratory of the Department of Health. The floors are of cement, and all corners and angles are rounded to prevent accumulation of dust and dirt; all furniture is enameled metal. In the basement lockers are placed for physicians' and attendants' gowns, individual stethoscopes, etc. The supplies (blanks, circulars, cards, etc.) of the clinic are also stored there.

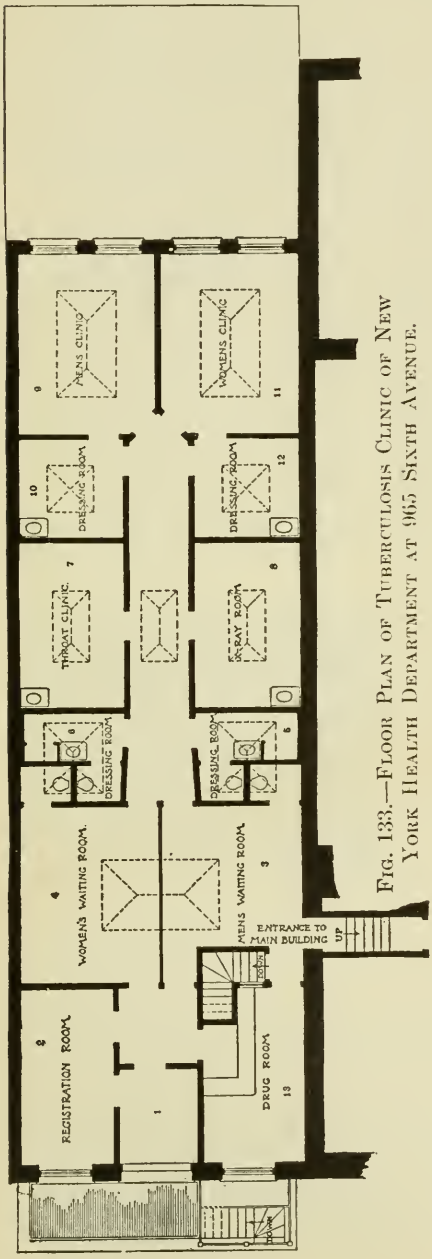

FIG. 133.—FLOOR PLAN OF TUBERCULOSIS CLINIC OF NEW YORK HEALTH DEPARTMENT AT 965 SIXTH AVENUE.

Large signs indicating that spitting on the sidewalk is prohibited are placed at the entrance door of the clinic, and

the following signboard (Fig. 134) in four languages greets the patient on his arrival in the waiting room:

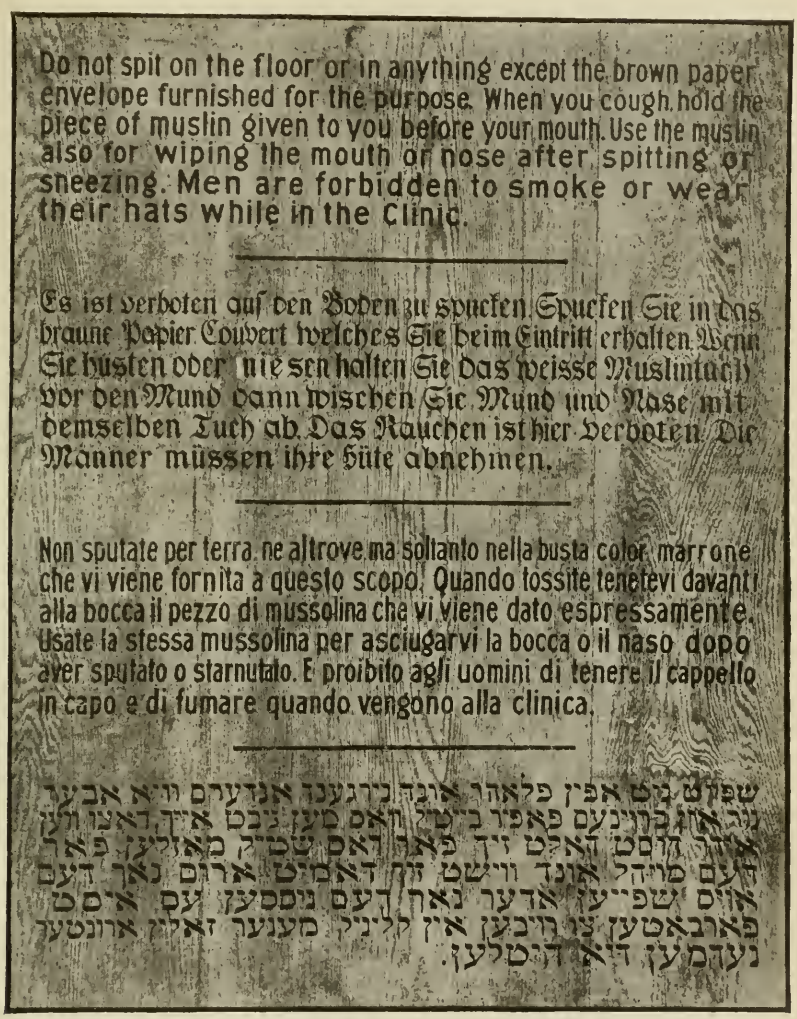

Fig. 134.—Signboard for Dispensary Waiting Room.

The New York Health Department, with the aid of the Dispensary Association, has undertaken the examination for tuberculosis of all the children of parents who frequent the tuberculosis clinics. The work is still in progress, and thus far, strange to say, only a relatively small number of tuberculous children have been discovered. Another interesting feature which has recently been inaugurated by the Tuberculosis Committee of the Charity Organization Society of New York is the

examination of certain professions; thus, for example, every individual belonging to a certain printer's union has been examined for tuberculosis. It must be evident that through such methods of examining thousands of children and adults, where the presence of tuberculosis may be suspected, a number of early or incipient cases will surely be discovered and a considerable number of lives saved.

In view of the time and care it takes to examine individuals suspected of tuberculosis, and to investigate their home environments and social conditions, it is almost impossible to do justice to all the cases which apply to the dispensary in a large city.

Advice and Care Stations.—To supplement the work of the dispensary, there have been recently established in Berlin, Germany, a number of advice and care stations for the tuberculous ("Auskunft und Fürsorge Stellen für Tuberkulöse") which do excellent work, both in the medical and social combat of tuberculosis as a disease of the masses. In these advice stations patients are not treated, but only examined and advised what to do and where to go. Investigations of home environments, social conditions, and the presence of other tuberculous members in the family are carefully made.

A very important feature of these advice and care stations is that they examine not only adults, but children as well. Thus, for example, according to the latest report of Dr. Kayserling, the general secretary of the central committee, no less than 6,924 children, 5,689 women, and 3,033 men, a total of 15,646 persons, were examined in the five Berlin stations within one year and seven months.

Dr. Arnold C. Klebs, who has visited these stations and investigated their work, says:

> To my mind these advice stations are of fundamental importance in the fight against the disease, provided they are similarly run to those in Berlin. They are more important than the dispensaries because they have a much wider radius of activity. In a fight against a disease which is so closely dependent on social conditions the institution which exerts a widespread influence is the most important. Everything else has its usefulness and its importance, but viewed from the standpoint of the masses and their health, I put the advice stations ahead of everything.

The writer agrees with Dr. Klebs that such advice and care stations might with advantage be established in some of our large American cities which desire to fight the white plague according to the most modern and efficient methods. It must be evident that through such institutions, combined with the dispensary work outlined above, the proper cases for sanatorium treatment can be more easily selected, the necessary isolation of hopeless cases accomplished, centers of infection

removed, unsuspected tuberculous cases discovered, unhygienic environments improved, and, last but not least, the children of tuberculous parents protected in time from contracting the disease.

The necessity for the timely care of children of tuberculous parents who may have inherited a tendency to tuberculosis or acquired it through unhygienic environments, has been demonstrated in France by the admirable work known as "L'Œuvre de préservation de l'enfance contre la tuberculose," inaugurated by the late Professor Grancher, of Paris.

This work, as instituted in Paris, consists in the main in removing the children of poor tuberculous parents from the center of infection, either to good sanitary private homes in the country or to seaside or inland sanatoria. There is no time limit; the children may stay away until, in the opinion of the supervising physician, they are strong enough to resist tuberculous invasion. The removal of these children is, of course, always done with the consent of the parents. The first complete report of the work of the society was given out at the recent tuberculosis congress at Paris, and showed most gratifying results. The sooner an improvement is made in the predisposed child's unhygienic environments, the greater are the chances for ultimately conquering his predisposition.

In placing children in country homes the greatest care must, however, be exercised to see that the infants or children do not enter worse hygienic conditions than they had left. Experience has shown that there are families in the country who make boarding such children a profitable business by confiding their care to the invalid of the family who is not able to do anything else. It must be evident that the invalid, if he or she is tuberculous, may thus frequently become a source of infection to the little ones.

Seaside and Inland Sanatoria for Tuberculous Children.—Children with tuberculous bone, joint, or scrofulous lesions seem to do best in seaside hospitals and seaside sanatoria. The statistics from European sanatoria, and of Sea Breeze Sanatorium at Coney Island, bear out this assumption (Fig. 135). However, institutions of this kind situated in mountainous regions and sometimes even in lowlands have also been productive of much good. As evidence of this may be mentioned the excellent work done by W. S. Halsted ('05), of Johns Hopkins Hospital, at Baltimore. All such institutions must, of course, have school facilities attached to them so that the mental development of the children may keep pace with their physical improvement. Where there are many children strongly predisposed to pulmonary tuberculosis or afflicted with the disease, special schools have been suggested. Outdoor instruction, whenever possible, should be the main feature of these schools.

Such a fresh-air school has recently been established in Providence, R. I. It was formally opened on January 27, 1908. The school is conducted indoors, with great swinging windows on three sides of each room, besides which an extensive system of ventilation affords an abun-

Fig. 135.—Open-air Treatment of Surgical Tuberculosis at Sea Breeze Coney Island. Spine cases treated with modified Bradford frame.

dance of cold, pure air, free from germs. The idea of establishing the school was first suggested by the Rhode Island League for the Suppression of Tuberculosis, which had heard of the satisfactory results obtained by schools of the kind in Europe. The pupils do not remove their outer wraps unless the weather requires closing the large windows. The teaching force of the institution has been selected largely from experienced instructors, and is under the direction of a corps of experts who have made a special study of the subject.

The dispensary and the advice stations will always have to serve as a clearing house.

Day Camps (Walderholungsstatten).—As an intermediary between the dispensary and hospital sanatorium there were established in Germany so-called day camps (Walderholungsstätten), situated in city parks or near-by forests. There ambulatory patients spend the greater part of the day, enjoying the open air, resting on reclining chairs or taking walks, all under careful medical supervision.

Many such stations also provide good substantial lunches. In the United States the first day camp, or day sanatorium, was established

near Boston on Parker Hill under the auspices of the Boston Association for the Relief and Control of Tuberculosis. The camp furniture is of the simplest sort, consisting of reclining chairs and a few cots for such patients as may be feverish. The patients come regularly, and are brought up the steep hill to the camp each morning, between 8 and 9.30 A.M., in a barge which meets them at Roxbury Crossing. Between 5 and 6 P.M. they walk slowly down the hill to the electric cars on Huntington Avenue, and return to their homes. A substantial hot dinner is served in the mess tent about noon, also a lunch on arrival in camp, and again just before leaving.

New York's Ferryboat Day Camp.—In New York City the establishment of near-by day camps on land is practically out of the question, owing to the distance the patients would have to go. The only available site for such an undertaking would be far up in the Bronx, and the tiresome journey by the subway or elevated railroad would offset any benefit that would be derived during the period spent at the camp. The Committee on Tuberculosis of the Charity Organization Society therefore gladly accepted the offer to utilize for that purpose one of the city ferryboats out of commission. Moored out at the end of the pier at West Sixteenth Street is the old Staten Island ferryboat *Southfield*, New York's newest day camp for consumptives. Pronounced unseaworthy, the old boat is still doing its part in the service of the city, and its decks, once thronged with an impatient crowd going to and from their work, now afford rest, fresh air, and sunshine for those who are battling with disease. The patients sent there from the dispensaries by private physicians (usually from fifty to one hundred in number) pass their days there, reclining in the sunshine and being benefited by the fresh river breezes.

The camp is under the supervision of a trained nurse with a sufficient number of assistants. The patients have the use of steamer chairs and present quite a cheerful gathering. There has been a gain in weight of nearly all the patients sent to this unique day camp. The routine day begins with the taking of temperatures and weighings. All the nourishing food that can be given is eaten. There is an abundance of fresh eggs and milk. Each patient eats from three to eight eggs a day and drinks from three to eight glasses of milk. Some of the patients bring light luncheons themselves, although bread, butter, and coffee are served on the boat at the expense of the society. Regular visits are paid by physicians who are medical members of the tuberculosis committee.

Class Method at Home.—Another way of taking care of the consumptive poor who must be treated at their homes is the so-called class method, which owes its origin to the zeal and devotion of Dr. Joseph

A. Pratt, of Boston. To define the class methods with treatment of tuberculous patients, one might say a number of patients, who for one reason or another cannot be under institutional treatment, are placed under the care of a physician or nurse or a friendly visitor, and the sanatorium treatment at home is applied throughout the year in order to obtain improvement or cure.

The patients may sleep outdoors in tents on roofs or extensions, and when this is not feasible a window tent, an aërarium, a sleeping canopy, or some similar device can be installed. If these are not available the windows of bedrooms are left wide open. Patients spend the greater part of the day outdoors, at rest, or taking careful walking or respiratory exercises. Patients keep a record of their daily doings, including temperature, cough, etc. They meet weekly to report to their physician and for the purpose of social intercourse. They are visited daily by the nurse or friendly visitor who devotes all her time to that purpose.

Before anyone is admitted to such a class, a promise of cessation of work and implicit obedience to the rules of the class is exacted. Such classes should never be larger than from 10 to 25, for more are hard to supervise by one nurse. To relieve the feature of possible pauperization, a small fee or membership due should be charged to all patients able to pay. The Emanuel Church Tuberculosis Class of Boston charges for this $2 per month. Since Dr. Pratt's successful venture with this method a number of cities have installed the class system, all with gratifying results.

Special Relief Work of Tuberculosis Committee of the C. O. S., New York.—Another matter of great importance which will help in taking care of the consumptive poor has been taken up by the Charity Organization Society's Tuberculosis Committee, which under the supervision of a subcommittee on relief work helps patients to come under the observation of the society's agents. The following is taken from the society's report of 1906, referring to the work done by the committee for the year 1905–1906:

That suitable cases might leave their families to enter hospitals and sanatoriums, there has been given to 15 persons relief in the form of "wage loss," the term used to denote the amount paid in to consumptive families to make up the wages lost by the consumptive through ceasing work in pursuance of advice given.

Twenty-two other families have been moved into better rooms, the committee paying moving expenses and excess of the new rent, as the case might be.

Rent has been paid for 36 others in their former apartments, where these rooms were suitable and where also there was a separate room for the consumptive.

For 18 others beds have been supplied, so that the patient might have a separate bed in a separate room.

Special diet, usually in the form of milk and eggs, has been provided in 139 cases, where the residence of the patient was so far removed from a dispensary or diet-kitchen station that he was practically cut off from this needed form of treatment.

Clothing has been supplied to 55 patients and sometimes to their families, and is a regular method of relief by the committee in cases going to hospitals. This form of relief will, of course, become more frequently necessary to patients exposed to the cold weather of the winter months while taking the "fresh-air cure."

Through the aid of the Committee on Employment for the Handicapped, 4 consumptives have been provided with employment of a character suitable to their physical condition, such as doorkeepers, etc.

Ten young girls and children were maintained in whole or in part at pay sanatoria for periods averaging one and a half to nine months. This was done because such treatment, though expensive, seemed the only method available of effectually returning these patients to wage-earning power, and the refusal to give such treatment seemed likely to lead to unavoidable physical decline along with the possibility of infection to others of the patient's family. Seven patients through the instrumentality of the committee were sent to the New York State Sanatorium for Incipient Tuberculosis at Ray Brook, and provided with clothing or such other assistance as was necessary. In one of these cases, of a young girl of seventeen years, whose parents were continually insisting on her working to add to the small family income, the family was prevailed upon to let her stay at the sanatorium for six months by the payment to them each week of $5, the amount the girl was earning before being taken out of work by friends who brought the case to the committee's attention. In another case the mother of five children was enabled to go to this same institution in the Adirondacks after her children had been sent to a reliable home in the country, where their board was paid by the committee for five months.

Seventy patients were sent to the country for stays varying from one week to five months, and lasting in 33 cases for three months or more, in 25 cases for two months and a fraction, in 9 cases for one month and a fraction, in 2 cases for half a month, and in 1 case for one week.

Tuberculous patients in the first stage of the disease, able and obliged to work, but who, by reason of their poverty, are forced to sleep in unsanitary and overcrowded homes, may be helped toward the cure of their disease by providing for them what might justly be called Night Camps. Here they could receive at least a good supper and a good breakfast, could be instructed in the hygiene and prevention of

tuberculosis, and be assured of a good night's rest in a well-ventilated room, tent, or shack. Any city could arrange for such a night camp on empty lots within or in the suburbs of the town, and a great deal of good would be accomplished thereby.

The special hospital should be located at not too great a distance from the city, and should receive the seemingly hopeless or more advanced cases. If any of the latter should improve they can easily be sent to a sanatorium. The sanatorium stands, of course, for what its name implies—a healing institution.[1]

Maternity Sanatoria.—Besides the sanatorium for consumptive adults and tuberculous children, there should be in every large community either a special maternity sanatorium or a special ward in an existing maternity hospital where tuberculous mothers could be received a few months previous to their confinement, and surrounded by the best hygienic and dietetic care. They should remain in the sanatorium for some time after childbirth. It is only by taking away these mothers from their unsanitary tenement homes, and placing them under constant medical supervision in such an institution, some time before and after their confinement, that the fearful mortality among tuberculous mothers after childbirth can be reduced.

The beneficial effect on the woman's and child's constitutions that might thus be accomplished can hardly be overestimated. Leaving aside the physical well-being thus largely assured to mother and child at a period when their organisms need the most tender care, the hygienic training which the mother will have received in such an institution will be of lasting utility to herself, to the family, and to the community.

These maternity sanatoria need not be situated at a great distance from the city. All that would be essential is that they should be erected on good, porous ground, preferably somewhat elevated, and in a locality where the atmosphere is as pure as possible. The buildings should be constructed in accordance with the principles of modern obstetric science and modern phthisiotherapy. The physician in charge should be experienced in both these branches of medicine.

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[1] The word sanatorium is used in preference to the word "sanitarium" for the following reasons: Brehmer, the founder of the first institution of that kind, called it "Heilanstalt," which means a healing institution; and the word "sanatorium," from the Latin *sanare*, to heal, gives certainly a better equivalent to the German word than the word "sanitarium." This latter word is derived from the Latin *sanitas*, health, and is usually employed in this country to designate a place considered as especially healthy, a favorite resort for convalescent patients, or an institution for the treatment of mental or nervous diseases. The word sanatorium for institutions for the tuberculous is now almost universally accepted, and the United States Government has officially accepted it by calling the government institutions by that name.

Medical Mission of the Tuberculosis Sanatorium.—The modern and ideal sanatorium for the treatment of consumptives has a medical and a social mission. The medical mission is manifold. By the admission of a patient to an institution, a dangerous center of infection is suppressed and the patient is given the greatest possible chance of cure. If in the advanced stage, he is made as comfortable as lies in the power of human skill with all the modern therapeutics at command. The sanatorium teaches that phthisiophobia is as unjust as it is cruel. It shows that the careful and conscientious consumptive is as safe an individual to associate with as anybody else, and that sanatoria for consumptives are not a danger to the neighborhood. It cures the consumptive whenever his case is curable, and demonstrates the curability of the disease independently of climate. It makes the patient a hygienic factor when he returns to his former environments and demonstrates the preventability of tuberculous diseases. The patient will have been taught the love of fresh, pure air by day and by night, to shun a vitiated atmosphere and the air of the saloon and the crowded meeting place. He will have learned the value of simple, pure, and good food, and how much more advantageous it is for him and his children to spend his money for food than for intoxicating liquors.

The sanatoria for children, some of which report as many as seventy-five per cent of cures, prevent many a strongly predisposed child from ever becoming a consumptive in later years or going through life crippled or deformed.

Social Mission of the Tuberculosis Sanatorium.—In summarizing the social mission of the sanatorium for tuberculous patients, we behold an even greater destiny. The sanatorium teaches true democracy, compassion and benevolence to the aristocratic, the rich, and the indifferent. It teaches the fallacy of a belief in alcohol as a food or specific for tuberculosis, and thus combats alcoholism. It teaches the disorderly to become orderly and offers to the uneducated an opportunity for education. It teaches love for fresh air, personal and general cleanliness, and thus indirectly prevents not only tuberculosis, but many other diseases whose origin must be traced to lack of fresh air, to filth, and to unsanitary habitation and habits.

The young medical man, entering the sanatorium as assistant, is given an opportunity to become a trained diagnostician of incipient tuberculosis, and thus he will be most helpful in the solution of the tuberculosis problem.

It has been asked what shall become of the number of sanatorium buildings when tuberculosis will have so decreased as no longer to fill them? This is a question that probably will not have to be answered for some time; nevertheless, by reason of their location and construc-

tion, the sanatoria for adults will make admirable homes for the aged and infirm who now crowd the almshouses and poorhouses, and the seaside sanatoria will give to the children and overworked mothers of our crowded cities much-needed vacation homes.

Duty of the Municipality toward the Family of the Consumptive.—While it is the duty of all municipalities and philanthropic institutions taking care of the consumptive poor and those of moderate means to be assured that the rest of the family do not suffer, and by privation also become victims of the disease while the breadwinner is in the sanatorium, it is of equal importance to use all possible means to prevent pauperization. A careful inquiry into the financial condition of every patient entering a people's sanatorium is as important as taking down the medical history and making the physical examination. By a visit to the home of a poor consumptive, after he has left for the sanatorium, much may be learned in the interest of all concerned. If the home is unsanitary, it should be brought to the attention of the respective authorities; if, for no fault of the family, there is want of food, fuel, or garments, they should be provided with these, and everyone who has lived with the patient now in the sanatorium should be examined to discover if there exists tuberculosis, some other disease, or a predisposition to any. By attending to these matters in time the municipality will again save money and lives. All this will be owing to the direct and indirect influence of the sanatorium.

Preventatorium.—A rather unique type of institution for the tuberculous owes its inception to Dr. Arthur J. Richer, of Montreal, Canada. Dr. Richer conducts, under the name of "Brehmer Rest," at Ste. Agathe des Monts, a charitable institution for the sole purpose of saving adults predisposed to tuberculosis from developing it. The class of patients received at Brehmer Rest are those convalescent from pneumonia, pleurisy, and typhoid fever, or such as are affected with chronic anemia, chlorosis, or who are so generally debilitated by other causes as to make them fit soil for the invasion of the tubercle bacilli. A sojourn of two or three months at Brehmer Rest usually suffices to overcome the tuberculous predisposition and to train the patient to be careful so that he may never develop the disease.

It must be evident that this is a great preventive work. The writer has visited Brehmer Rest and convinced himself of the good which may be accomplished by this method of treating a pretuberculous state, if it may be so designated. He has suggested to Dr. Richer the name of "preventatorium," or preventorium, for the institution, and Dr. Richer thought favorably of it. The name Brehmer Rest hardly conveys the idea for which the institution stands, while the word preventatorium means an institution consecrated to the cause of prevention.

It would seem that the preventatorium as conceived by Dr. Richer is perhaps as essential a weapon to combat tuberculosis in the adult, or to prevent its development, as "L'Œuvre de préservation contre la tuberculose des enfants," called into life by the late Professor Grancher of Paris, is for the child. One saves children, the other adults, from contracting the disease by fortifying the system against the probable invasion of the tubercle bacillus. Works like that of Professor Grancher and that of Dr. Richer are striking at the very root of the evil, and the more preventatoriums for adults and the more "preservatoriums" for children we have, the more readily shall we master the tuberculosis problem.

Agricultural and Horticultural Colonies.—Lastly, for the cured and arrested cases we will have to create agricultural and horticultural colonies, or other industries whereby the recovered pulmonary invalid may have a chance to make his cure lasting by following a healthful outdoor occupation for some time before returning to his old trade or profession.

While much has been done, there is more to do, and we in America are far removed from the time when we shall have too many sanatoria for adults or children. The municipal, State and Federal governments should combine with individual efforts more energetically than heretofore in the establishment of all institutions intended for the preservation and treatment of tuberculosis.

Remuneration of Physicians in Public Tuberculosis Institutions.—There is one point, however, which the municipality must bear in mind. It has been shown, when speaking of the economic value of the cured individual, that the municipality gains directly financially and indirectly socially. The bulk of the work in dispensaries and advice stations, in treatment of the poor at home, in special hospitals, and sanatoria, must be done by the physician. The latter must devote a great deal of his time to this cause. It is but right, reasonable, and just, therefore, that a physician devoting a number of hours daily to the patients in the dispensaries, special hospitals, and other institutions where the poor are received, should be remunerated properly. When the community is the financial gainer through the physician's work and devotion, the latter must not be the financial loser.

Compulsory Notification of Tuberculosis Cases and the Work of the Health Department in Relation Thereto.—A municipality which makes registration compulsory accomplishes but one half of its work when it does not at the same time supply sanatoria and hospitals for cases which cannot be properly treated at home. But where such sufficient provision exists, compulsory notification of tuberculous cases, when tactfully inaugurated and carried out, cannot but be productive of good, and will further the interests of the general practitioner, the patient, and the

community as well. A partially voluntary and partially compulsory notification of tuberculous cases was first inaugurated in New York by Dr. Hermann M. Biggs, of the Health Department, in 1893. Public institutions were required to report cases coming under their supervision, and private physicians were requested to do so. Under this provision the Department of Health carried on this work for three and a half years, and then adopted in 1897 regulations requiring the notification of all cases.

The following is a card which the Health Department furnishes to the practitioner for him to utilize in notifying the department of a case of tuberculosis. It shows for itself that no interference on the part of the department is intended.

REPORT OF CASE OF TUBERCULOSIS

New York,.....190

Name of Patient.....Age.....
Sex.....Occupation..... Color.....Nationality.....
Residence.....Care of.....
No. families in house.....No. in family.....
Previous cases in family.....
Do you wish an Inspector to visit the premises and instruct the family regarding prophylaxis? Answer Yes or No.....

.....M.D.
Residence.....

NOTE—Private cases of tuberculosis where there is a physician in attendance will NOT be visited by the Department of Health except upon request.

The same tact is used in the case of a dispensary patient, and the dispensary assures the department that patients are sufficiently instructed and supervised. The following is the card used for that purpose. Institutions which treat a number of cases of tuberculosis receive special cards for the purpose of reporting.

DISPENSARY TUBERCULOSIS CARD

REQUEST NOT TO VISIT

New York,.....190

Name of Patient.....Age.....
Sex.....Occupation..... Color.....Nationality.....
Residence.....Care of.....

This case is under supervision at home and the Department of Health is therefore requested NOT to send a nurse or inspector to visit the patient. Notice will be sent of any change of address, or discontinuance of attendance.

.....
(Name of Dispensary or Charitable Organization reporting case)

NOTE—This card is simply a request *not* to visit, and is not a report. All cases must also be reported in the regular way: by special institution postal card or by the sending of a specimen of sputum. Private cases of tuberculosis where there is a physician in attendance will *not* be visited by the Department of Health except upon request.

Dr. H. M. Biggs ('04) showed the value of compulsory notification when combined with sanitary supervision and sanatorium and hospital provisions. He says:

During the last ten years there has been a decrease of forty per cent in the death-rate in children under fifteen years in pulmonary tuberculosis and tuberculous meningitis, these being the two forms of tuberculous disease in which an approximately accurate diagnosis is likely to be made. It is precisely in this, the youngest element of the population, that one would first look for definite results from the enforcement of measures for the restriction of the disease.

It would seem that this remarkable result certainly justifies compulsory registration. The methods adopted by the New York Health Department have been looked on as, perhaps, the best and most efficient, and for this reason a description of the routine procedure adopted by the Health Department, as it has been tersely given by John S. Billings, Jr. ('06), is of interest:

The sanitary supervision of pulmonary tuberculosis in the different boroughs of the city is carried on by means of the same staff of inspectors who administer diphtheria antitoxin. The staff of nurses is apportioned as follows: Manhattan, seven; Brooklyn, four; Bronx, one, and Richmond and Queens, one. Each nurse has a certain section of the city assigned to her.

Cases of tuberculosis are reported to the Department of Health by (1) private physicians, (*a*) on the postal cards furnished, (*b*) by the forwarding of specimens of sputum for examination to the Diagnosis Laboratory; (2) institutions (hospitals, sanatoria, dispensaries), on postal cards furnished; (3) death certificates, forwarded to the Bureau of Records; (4) complaints from lay individuals or organizations; (5) employees of this and other departments of the city.

The various records, files, indices, etc., of cases of pulmonary tuberculosis center around an alphabetical "name" index, in which the name, age, address, date, case number, and source of report of every living case are entered, together with the name of the subindex in which the record card is filed. The actual record cards are filed in different subindices according to circumstances, as follows:

1. "Private cases" (p. c. on name card), reported by private physicians and not visited by inspectors or nurses.

2. "At home" (a. h. on name card); cases at their homes under supervision by the department (i. e., not under the care of the physician).

3. "Hospital" cases ("hosp." in the space for name of institution), reported as having entered a hospital.

4. "Not found" cases (n. f.); those not found at address under which reported.

5. "Dead" cases (name card is destroyed).

6. "Out of town" cases (o. o. t.); reported as having left the city.

7. "No case" and "Recovered" (n. c.); found on investigation not to be cases of tuberculosis, or reported as recovered.

On the receipt of report of a case, from whatever source, it is first searched for in name index. If it is a (previously unreported) case, a record case number is assigned (beginning each January 1), which is written on the original postal card or report card from Diagnosis Laboratory in red ink. If an old case (a duplicate), the old number is written in black ink. A blue "record" card is then made out, on which all essential facts are entered, and (later) every official action and recommendation of the department, dates of inspection and by whom, records of fumigation and renovation, forcible removal, etc., changes of address, entrance into hospital, duplicate reports, etc., are also noted on this card. The original report is then filed in "report card" index, according to date of receipt. Only postal cards and sputum report cards are so filed; all other forms of reports are transferred to a postal card before filing. This index is kept for five years.

A record is kept of every case assigned to an inspector or nurse by means of a "tally" index showing exactly what cases are being investigated by each inspector and nurse. A small "tally" card for each case is filed under the employee's name, and is only removed on receipt from him or her of all cards, etc., relating to the case. This index is gone over once a week and any delays inquired into.

Private cases are not visited except at the request of the attending physician. A letter is sent to the physician acknowledging receipt of report, calling his attention to the necessity for reporting any change of address or discontinuance of treatment on the part of the patient, and inclosing a circular of instruction, which (or its equivalent) the physician is requested to give to the family of the patient or to the patient himself. A card index is kept of the names of all physicians reporting "private" cases, together with the names of cases. The large record card is then filed in the "private" case index according to patient's address. Once a year a letter is sent to the attending physician of every "private" case, asking for information as to outcome of case. If no answer is received, the case is followed up by the department. Such cases, if found (also all "private" cases reported later by institutions), come under the supervision of the department, the "p. c." on name card being stricken out.

At home cases are reported by (*a*) dispensaries and charitable organizations, (*b*) laymen, (*c*) physicians, with request that they be visited, and (*d*) hospitals, as having been discharged. Such cases are at once assigned for investigation and report to the nurse in whose district the patient lives. The date of assignment and name of nurse are entered on blue record card, which is mailed to the nurse. If the patient is found, a pink "observation" card is filled out, giving all essential data (if not found, that fact is noted on record card, which is returned). Record and

observation cards are returned by mail on the day of inspection. Any recommendations (hospital, charitable aid, etc.) are indicated by writing date in proper space on record card. If case is kept under observation, a white "nurse's" card is filled out and returned, on same being entered all records of weekly visits. On termination of supervision (by death, improvement, removal to hospital, removal outside nurse's district, etc.) the nurse's card is returned. Recommendations by nurse during observation or on termination of case (for disinfection, forcible removal, etc.) are made on a special postal card. On receipt of record at borough office, (1) if tuberculosis case was "not found," that fact is indicated on name card and in book for recording number of "not found" cases, and card is filed in "not found" index. A letter is sent to individual who reported the case, requesting correct address. (2) If found, the record card is stamped "observation card" on left-hand margin, and filed in "at home" index. If not to be kept under observation by the nurse, the pink "observation" card is filed with it; if kept under observation, the pink card is filed in the "tally" index under nurse's name, forming record of cases under her observation. Each week a record is kept of number of cases under observation in each district. On return of white "nurse's" card, it is attached to observation card and record card, and appropriately filed.

Cases needing charitable assistance are referred to the Charity Organization Society, Association for Improving the Condition of the Poor, United Hebrew Charities, Brooklyn Bureau of Charities, etc., by telephone and postal card, a card index being kept of all such recommendations.

Milk, two quarts daily for one month; eggs, three daily for two weeks, are issued in cases where such extra diet is called for as a part of treatment. On recommendation of the nurse an order on the nearest depot is issued, a record being kept of all recommendations. The following are the depots:

Manhattan Diet Kitchen Association: Raymond Kitchen, 423 West Forty-first Street; Rusch Kitchen, 146 East Seventh Street; Freeman Kitchen, 335 East Twenty-first Street; Wickham Kitchen, 137 Centre Street; Gibbons Kitchen, 140 East Ninety-seventh Street; Hackley Kitchen, 26 Barrow Street; Anne Barbara Kitchen, 205 West Sixty-second Street. Brooklyn: Brooklyn Bureau of Charities, 1600 Fulton Street, 191 Marcy Avenue, 69 Schermerhorn Street, 174 Johnson Street, 98 Sackett Street, 255 Division Avenue.

Sputum cups, both pocket and home (metal framed with removal filling), are issued by the nurses.

Instructions are given to the patient and his family, both verbally and by means of the "Circular of Instruction to Consumptives and those Living with Them" (see Appendix), each circular being printed in English and one other language—German, Italian, Yiddish, Ruthenian, Slovak, Polish, Bohemian, and Chinese.

Cases of tuberculosis attending the dispensaries of Gouverneur, Belle-

vue, Presbyterian, and Harlem hospitals, and the Vanderbilt Clinic, and kept under observation by the nurses of these dispensaries, are not visited. In order to avoid duplication of visits, these dispensaries are furnished with postals to notify the department that the case is being kept under observation. These postals are filed under the name of the dispensary, forming a record. Twice a year this is compared with the records at the dispensary. All cases must also be reported in usual way, but are held two weeks awaiting receipt of special dispensary postal. If not received, patients are visited.

All suitable cases are urged to enter a hospital; if consent is obtained, the recommendation is made on proper space on record card, date and name of institution preferred being given. If recommended to Riverside Hospital, the patient's name is placed on waiting list; when vacancy occurs, an admission card is made out and delivered by the district nurse, who obtains information called for on card and reports as to necessity for ambulance, coupé, etc. In emergency cases, when an ambulance is required, the hospital in whose ambulance district the patient lives is requested to remove the patient to Bellevue, whence he is transferred to the Metropolitan Hospital or to St. Vincent's Sanatorium.

Ambulance districts in the Borough of Manhattan:

Gouverneur Hospital—Houston to Front streets, Bowery to East River.
Bellevue Hospital—Houston to Forty-second streets, Fourth Avenue to East River.
Flower Hospital—Forty-second to Fifty-ninth streets, Sixth Avenue to East River.
Presbyterian Hospital—Fifty-ninth to Ninety-sixth streets, Fifth Avenue to East River.
Harlem Hospital—Ninety-sixth Street to Harlem River, Lenox Avenue to East River.
J. Hood Wright Hospital—Eighty-sixth Street to Kingsbridge, Lenox Avenue to North River.
Roosevelt Hospital—Twenty-seventh to Eighty-sixth streets, Eighth Avenue to North River; Forty-second Street to Sixth Avenue to Fifty-ninth Street.
New York Hospital—Fourteenth to Twenty-seventh streets, Fourth Avenue to North River; Twenty-seventh to Forty-second streets, Seventh Avenue to Park Avenue.
St. Vincent's Hospital—Fourteenth Street to Canal Street, Fourth Avenue to North River.
House of Relief—Catherine Street to North River, Canal Street to Battery.

All requests for admission to the hospitals of the Department of Charities, and also to St. Joseph's, Seton, and Lincoln hospitals, are referred to the Department of Charities by telephone, by a double card (one half being given to patient and the other being filed in borough office), and by postal card.

When the necessary precautions cannot or will not be observed, and when others (especially children) are exposed to infection, a patient may be removed to Riverside Sanatorium by force, if necessary, even if consent of patient or family is not obtained.

When patients continue at work and may be sources of danger to their fellow workmen, the employer is visited and notified as to the danger of infection and precautions to be taken. Placards forbidding promiscuous spitting are furnished free, to be put up in the workplace.

When it is evident that premises will need renovation after removal of patient, the owner or agent is required to promptly notify the department when such removal takes place, and also as to new address. A postal card is also left by the nurse with such patients, on which any change of address is reported.

All unsanitary conditions (bad drainage, leaky plumbing, etc.) are reported. If occurring in a tenement house, the complaint is referred to the Tenement House Department; if not, to the Division of Inspectors of the Department of Health. (A tenement is any house containing three or more families.)

On death, removal to a hospital, or change of address of a case "under observation," the district nurse is notified by postal to return all cards, etc.

When patients are not receiving medical care they are referred to one of the tuberculosis clinics of the Department of Health, a double reference card being used, one half being given to the patient, and one mailed to clinic.

Every hospital must report all discharges and transfers of cases of tuberculosis. Every case returning home is at once visited to see if treatment is being continued, instructions observed, etc. Each morning a report is obtained by telephone from Seton, Lincoln, St. Vincent's, Metropolitan, St. Joseph's, and Riverside hospitals of (*a*) all patients discharged the day before and (*b*) of all cases to be discharged three days later. The former (*a*) are noted on a "discharge card" and visited at once, as many of these patients remain at home only a day or two. The latter (*b*) are noted on a "nurse's discharge" card, and each case assigned at once by telephone to the district nurse for investigation as to whether patient should be allowed to return home. She reports by telephone within twenty-four hours, her report being entered on card, which is filed, and hospital notified. Should a patient returning to unfavorable home surroundings, or giving wrong address, insist on being discharged, the patient can be transferred to Riverside Hospital.

All cases reported by lay individuals and organizations and nurses are classed as "suspected" cases and are visited by the district medical inspector, who reports results of physical examination and nature of ailment on observation card. The original report cards are filed separately until the case has been reported on, when person reporting case is notified of result. If case proves to be one of tuberculosis the usual routine is followed, except that when inspector recommends that case be kept under observation, the record and observation cards are filed, and a white nurse's

card filled out and sent to district nurse. If not tuberculosis, it is classed as "no case," so recorded in name index, and filed. All complaints by citizens (as to spitting, necessity for hospital treatment, etc.) are investigated by a district inspector, who submits a formal report. If there is a physician in attendance, he is visited and requested to see that nuisance is abated, if one exists.

All apparently incipient cases seen by nurses and inspectors, or calling at borough offices, are referred by card to a tuberculosis clinic of the department for examination as to their eligibility for sanatorium treatment. Very incipient cases are referred to the New York State Hospital for Incipient Tuberculosis. Suitable cases are also referred to the Stonywold, the Loomis, and the Adirondack Sanatoria.

Only in the most exceptional cases are children with tuberculosis allowed to attend school. Such cases are excluded from school by medical school inspectors, pending their examination at one of the tuberculosis clinics of the department, whence a report is sent to the Division of Contagious Diseases. Every effort is made to have such children enter a sanatorium or hospital.

Every hospital in New York City is required to report all cases of tuberculosis within one week of their admission, using a postal card furnished. Each hospital and dispensary is visited once a month and their supply of the various reporting cards replenished. The larger hospitals (Bellevue, Metropolitan, etc.) report daily. A weekly record book is kept of the number of cases (new and duplicate) reported by each institution throughout the year. When no report is received within two weeks, inquiry is made by telephone. The yearly totals are compared with the number of cases given in the annual report of each institution.

Twice a year (March 1 and August 1) a census is taken of all cases of tuberculosis in institutions in New York City, a special blank being supplied to each institution. These censuses are compared with the "hospital index"—i. e., the cases supposed to be in each hospital—and all discrepancies investigated, the results for each institution being recorded. Every case reported as entering a hospital is assigned to a district inspector, who recommends the necessary renovation, fumigation, and disinfection of bedding, such recommendations being recorded in the proper space on the record card by means of the date. (It is also stated if patient will return to premises or not.) According to the condition of the premises, the inspector may recommend: (*a*) That nothing need be done. This is most exceptional, only obtaining in very clean apartments and those where the patient only spent one or two nights on the premises. (*b*) That the room occupied by the patient be fumigated with formaldehyde. (*c*) That the patient's room be thoroughly renovated, the walls and ceilings washed and recalcimined, repapered or repainted, and the woodwork and floors be washed and repainted, the rest of the apartment being fumigated with formaldehyde. (*d*) That the whole apartment be renovated. Renovation of the premises (washing of floors and woodwork with antiseptic solution, repapering, painting, and calcimining) is recommended on a

complaint blank, which, after being approved and journalized, is forwarded to the Sanitary Superintendent for enforcement. When cancellation, extension of time, or modification of order is asked for, the case is reinspected by the original inspector. When there is reason to believe that renovation will be evaded, or where the premises are vacated by the death or removal of the patient and renovation has been ordered, the inspector orders the premises placarded. A paster is then filled out at the borough office, journalized, and forwarded to the Division of Inspections to be put up. When owner or agent voluntarily performs renovation, that fact is reported, a yearly record being kept of the number of such voluntary renovations. Fumigation with formaldehyde and disinfection of bedding is ordered on a card, on which number and size of room, date fumigation is to be performed, etc., are noted. All fumigation orders for the day are entered by inspector on a slip, which is forwarded with the fumigation cards to the Division of Contagious Diseases. In an emergency the fumigation order can be telephoned, but the card is also submitted. All bedding is fumigated before it is removed for disinfection, for the protection of the department employees, and is returned in twenty-four hours. The tally card of the case is filed separately as a check on fumigation. The fumigation card is returned by Division of Contagious Diseases after its recommendations have been complied with, and the tally card is destroyed and fumigation card is filed according to date, being kept about four months.

On receipt of record card from inspector it is filed in "hospital index" alphabetically, according to name of hospital, which is written on a small name card. In cases reported as having moved to a new address or having left the city, the same routine procedure is followed out. In cases living in private houses disinfection can be done under the supervision of the attending physician, but he must submit a certificate. Lodging houses are not disinfected, that being the duty of the managers of such houses.

When an inspector or nurse reports that no record can be found of a case at the address given, a letter is written to the person reporting the case, requesting the correct address. If this cannot be found the name card is marked "n. f." and the record card filed in the annual "not found" index. These files are kept three years, when the record cards are destroyed and the name cards removed from the name index and filed in an "old not found name index." A daily record is kept of the number of "not found" cases reported.

All deaths from tuberculosis occurring during the preceding twenty-four hours are reported daily by the Bureau of Records. The record and name cards are stamped "Dead," and the former assigned to inspectors to order the necessary fumigation, etc., the latter being used as a tally card, and all cards of the case filed in "dead" index for the current year, which is kept for two years before being destroyed. Every previously unreported dead case receives a special serial case number, and a letter is written to the attending physician or institution calling his attention

to the violation of the Sanitary Code and requesting an explanation. Should no answer be received, a second letter, signed by the secretary of the department, is sent, demanding an explanation on pain of prosecution. A record is kept under each physician's name of all such unreported cases, nature of explanation, etc. (unreported cases of typhoid fever, cerebrospinal meningitis, etc., are recorded in the same index). All deaths from pneumonia are daily compared with tuberculosis records. If case had been previously reported during life as tuberculosis, an inspector visits the physician who signed the death certificate and obtains an explanation of the apparent discrepancy, submitting a report on special blank. The same is done for all cases of tuberculosis reported as having died from some other cause. The Bureau of Records is also notified of any change of diagnosis and death certificate corrected.

Every new case of tuberculosis reported in Manhattan is plotted on a large map of the borough, which shows each house ("not found" cases, of course, excepted). The address is written on a small white card (of private cases, on receipt of postal or sputum report; of all others, on receipt of inspector's or nurse's report stating that patient did live at address given). In Richmond and Queens the cases are plotted on compoboard map by means of colored pins.

All cases are admitted here through the Division of Communicable Diseases, the names and addresses of applicants being placed upon the waiting list. When a vacancy occurs an admission card is filled out for the first eligible case. ("Forcible removal" cases alone take precedence.) This is assigned to a nurse for delivery, who obtains data called for on card and leaves same with patient. If coupé or ambulance is necessary, the borough hospital is requested to remove the patient. All patients must reach Reception Hospital, at East Sixteenth Street, Manhattan, by 1 P.M., as the boat leaves at that hour. Walking cases may cross at East 132d Street, whence a boat leaves every hour between 9 A.M. and 5 P.M.

No patient is allowed out on pass or is discharged until the conditions at his home have been investigated and found satisfactory. A daily report of cases, deaths, discharges, and admissions is received by telephone each day and added to daily report to Sanitary Superintendent. Every case admitted, discharged, or dead is reported daily on a special card, which is filed according to date.

All inspectors and nurses bear in mind that the Department of Health pledges itself not to interfere in any way with cases of pulmonary tuberculosis under the care of a private physician, except where a complaint is made. Even then the attending physician, if there is one, is first visited. The source of complaint is never divulged.

The Inspector-in-Charge examines daily all cards, reports, etc., forwarded by inspectors and nurses, sees that the various recommendations are carried out, and various records, map cards, etc., are kept. When cards are incorrectly or incompletely filled out the district inspector or nurse is summoned to the borough office.

All cases reported as living in other boroughs are reported daily to the office of the borough in which they live. When a patient moves to another borough all cards and records of the case are forwarded to the office of that borough.

Inspectors report at the borough office every Monday at 9.30 A.M., bringing with them all cards, etc., in their possession, to be compared with tally index. All inspections are made within three days. Special assignments (forcible removals, diagnoses of suspected cases, etc.) are attended to immediately. Every entry on back of blue record card is dated. An observation card is made out for every case seen, whether tubercular or not, and the result of physical examination written in space "present condition."

In ordering fumigation the date on which it is to be done is always given on the card. Unless the premises are in very bad condition it is usually sufficient to renovate the room occupied by the patient and to fumigate the rest of the apartment. Where the entire premises are probably infected, renovation should be complete. In cases where the premises are in very good condition, fumigation of the room occupied by the patient may be all that is necessary.

Great care and accuracy are necessary in recommending the kind and amount of renovation necessary, both for the sake of justice to the owner and because an error means a reinspection, probably rescindment of the order for renovation, and the submitting of a new complaint. The floor and position of the premises are always noted on the blue card, complaint, fumigation card, etc. The full name of the owner or agent is given in complaint; if it cannot be obtained, the fact is stated. All cards and reports, without exception, are mailed on the day the inspection is made. The regular blank is used for all reports.

To explain the word "forcible removal" it must be said that the Department of Health, having police powers, can remove a patient to the Riverside Sanatorium by force, if necessary, even if his consent or that of his family is not obtained, when in the opinion of the authorities the necessary precautions cannot or will not be observed, or when others, especially children, are exposed through him to tuberculosis.

It may be interesting to know something of the ultimate behavior of patients under such enforced removal. The writer has been the senior attending physician ever since the institution was opened five years ago, and vouches for the fact that in nearly every instance the patient, having usually been removed from a dark, dreary, overcrowded tenement, from an unclean room and bed, where very often he had insufficient nourishment, into a clean bed in a bright, cheery, airy, and well-ventilated ward of the Riverside institution, where he receives plenty of good food and considerate treatment, was glad to remain.

In but two instances was dissatisfaction shown or an attempt made to escape.

Compulsory Registration in the United States Considered by a Layman.—The compulsory reporting and registration of tuberculous cases in the United States has been made the subject of a careful study by Mr. William H. Baldwin ('06), of Washington, D. C., a layman, but deeply interested in the problem, and a director of the National Association for the Study and Prevention of Tuberculosis. From his admirable article on this subject (*New York Medical Journal* of December 8, 1906) are reproduced tables giving the present status of compulsory registration of tuberculosis in the United States and some of Mr. Baldwin's personal comments:

Since tuberculosis is known to be an infectious and communicable disease, it might be expected that the first step to be taken toward controlling it would be to require each case to be promptly reported to the proper authorities, as is done with other communicable diseases; but when this course was first proposed it met with many objections, due partly to the lack of knowledge among the public as to the nature of the disease and partly to the fact that it differs in some important respects from other communicable diseases.

These objections came mostly from physicians, who are naturally conservative, and who opposed such reports on the ground that they interfered with the confidential relations of patient and physician; that they would be made public, and so cause patients to leave physicians who made such reports and go to those who refused to make them; but such patients would be injured in various ways by allowing others to know they had tuberculosis, and that a stigma would also be placed on the family in which the disease existed.

Experience where such reports are made has shown that these objections are not well founded; and in order to bring this experience up to the present time an inquiry was made in the last part of 1905 and the first part of 1906 as to such reports in all cities of the United States having, according to the census bureau, a population of 48,000 or more in 1903, of which there are eighty-six. The health department or board of health in each city was asked, among other things:

Whether the city had any ordinance or regulation requiring the report and registration of all cases of tuberculosis; whether or not such reports were kept private when made; whether any difficulty was experienced in keeping them private; whether there was now any serious objection on the part of physicians to making such reports.

Replies received show that such reports are required in 53 cities out of the 86, of which 14 require reports of all forms, 16 of pulmonary only, and 23 did not state whether reports of other forms than pulmonary were required or not. (See Tables 1 and 2.)

TABLE 1.—*Cities having Compulsory Law for Reports and Registration of Cases of Tuberculosis, with Population and Date of the Passage of Such Law in Chronological Order.*

CITY.	Population, Census 1900.	Date of Law.
New York	3,437,202	January 18, 1897.
Camden, N. J.	75,935	December 27, 1897.
Cincinnati, Ohio	325,902	August 19, 1898.
Elizabeth, N. J.	52,130	March 6, 1899.
Boston, Mass.	560,892	May 1, 1900.
Buffalo, N. Y.	352,387	1900.
Rochester, N. Y.	162,608	1900.
Trenton, N. J.	73,307	January 8, 1901.
Bridgeport, Conn.	70,996	April 23, 1902.
Lowell, Mass.	94,969	September, 1902.
Worcester, Mass.	118,421	October 8, 1902.
Louisville, Ky.	204,731	October, 1902.
Atlanta, Ga.	89,872	October, 1902.
Oakland, Cal.	66,960	1902.
Providence, R. I.	175,597	January 15, 1903.
Hartford, Conn.	79,850	March 4, 1903.
Cambridge, Mass.	91,886	March 11, 1903.
Omaha, Neb.	102,555	June 30, 1903.
San Francisco, Cal.	342,782	October 27, 1903.
Los Angeles, Cal.	102,479	October, 1903.
Memphis, Tenn.	102,320	1903.
St. Paul, Minn.	163,065	January, 1904.
Minneapolis, Minn.	202,718	August 26, 1904.
Reading, Pa.	78,961	September 1, 1904.
Somerville, Mass.	61,643	October 6, 1904.
*Des Moines, Ia.	62,139	October 28, 1904.
Springfield, Mass.	62,059	November 1, 1904.
Cleveland, Ohio	381,768	February 3, 1905.
Youngstown, Ohio	44,885	February 6, 1905.
Yonkers, N. Y.	47,931	February, 1905.
Paterson, N. J.	105,171	March 3, 1905.
*Salt Lake City, Utah	53,531	March 9, 1905.
Grand Rapids, Mich.	87,565	March, 1905.
St. Louis, Mo.	575,238	April 7, 1905.
*Baltimore, Md.	508,957	April 8, 1905.
†Philadelphia, Pa.	1,293,697	April 27, 1905.
New Haven, Conn.	108,027	April, 1905.
†Milwaukee, Wis.	285,315	May 15, 1905.
Fall River, Mass.	104,863	June 13, 1905.
Waterbury, Conn.	45,859	September 5, 1905.
†Pittsburg, Pa.	321,616	September 10, 1905.
New Bedford, Mass.	62,442	November 8, 1905.
Columbus, Ohio	125,560	1905.
Erie, Pa.	52,733	January 1, 1906.
Chicago, Ill.	1,698,575	January 1, 1906.
Lawrence, Mass.	62,559	February 19, 1906.
Peoria, Ill.	56,100	February 20, 1906.
Detroit, Mich.	285,704	
Holyoke, Mass.	45,712	
Seattle, Wash.	80,671	
Wilkesbarre, Pa.	51,721	
Troy, N. Y.	60,651	
Indianapolis, Ind.	169,164	

* State law. † State law: enforcement in this city began at about this time.

TABLE 2.—*Cities which do not have Compulsory Report Laws for Reports of Cases of Tuberculosis*

CITY.	Population, Census 1900.	CITY.	Population, Census 1900.
New Orleans, La.	287,104	Lynn, Mass.	68,513
Washington, D. C.	278,718	Savannah, Ga.	54,244
Newark, N. J.	246,070	Hoboken, N. J.	59,364
Jersey City, N. J.	206,433	Evansville, Ind.	59,007
Kansas City, Mo.	163,752	Manchester, N. H.	56,987
Denver, Colo.	133,859	Utica, N. Y.	56,383
Toledo, Ohio.	131,822	Kansas City, Kan.	51,418
Allegheny, Pa.	129,896	San Antonio, Tex.	53,321
Syracuse, N. Y.	108,374	Duluth, Minn.	52,969
St. Joseph, Mo.	102,979	Charleston, S. C.	55,807
Scranton, Pa.	102,026	Norfolk, Va.	46,624
Portland, Ore.	90,426	Harrisburg, Pa.	50,167
Albany, N. Y.	94,151	Portland, Me.	50,145
Dayton, Ohio.	85,333	Houston, Tex.	44,633
Richmond, Va.	85,050	Schenectady, N. Y.	31,682
Nashville, Tenn.	80,865	Fort Wayne, Ind.	45,115
Wilmington, Del.	76,508		

In six cases the date when the law was passed was not given, but in the others it took effect as follows:

YEAR.	Cities.	YEAR.	Cities.
1897	2	1902	6
1898	1	1903	7
1899	1	1904	6
1900	3	1905	17
1901	1	Three months of 1906.	3

This shows a decided awakening to the necessity of such reports.

The total population of these eighty-six cities by the census of 1900 was 17,270,126, nearly one quarter of the population of the United States. The fifty-three which require reports had a population of 14,030,381, or 81.2 per cent, while those not yet having such a law contained 3,239,745, or 18.8 per cent.

In the large cities this proportion is still greater, for of the twenty largest cities, sixteen, containing 10,953,081, or 91.5 per cent, have such a law, and four, with 1,018,325, or 8.5 per cent, do not; so that considerably less than one tenth of the population in the twenty largest cities do not have this regulation, and such reports are required in all the thirteen largest.

As to privacy, nine cities do not state whether the reports are kept private or not, two say that no one has asked to see them, seven that the reports are kept private, and thirty-one that they are "kept private without difficulty"; while in only three—Seattle, Des Moines, and Wilkesbarre—it is stated that the reports are open to the public. This furnishes

conclusive proof that such reports can be kept private, as they should be, and that the objection of harm to the patient or his family by reason of publicity from such a report is without force.

The information as to the attitude of the medical profession in the different cities is a little more difficult to classify, as circumstances vary, and, as the dates given show, the laws in twenty cities have been in existence but a year or less, and in some were apparently not yet vigorously enforced; but the substance of the replies was as follows:

Cities in which there is no objection, or practically none	34
Cities in which there is little objection	11
Cities in which physicians object	5
Cities which do not state	3
Total	53

One of the cities objecting is Detroit, Mich., where an attempt to enforce the penalty resulted in a lawsuit, which was carried to the Supreme Court of the State and was not decided at last accounts. Pending this no attempt is made to enforce the ordinance, which still stands. It is apparent, however, that opposition is decreasing with the increase of knowledge on the subject, and in New York City, where the law has had the longest and most thorough trial, it is said that there is now "no objection whatever." The records show that in more than ninety per cent of all deaths from tuberculosis in that city the case has been previously reported to the health department.

In many of the cities it is difficult to determine from the replies just what proportion of all cases is reported. Some cities are evidently lax in the enforcement of the law, but the greater number make an honest effort to secure reports of all cases, and one declares that, so far as is known, they get them all. The results indicate an increasing efficiency on the part of the authorities commensurate with the growing interest in the subject.

The laws differ somewhat as to the action to be taken by the health authorities when a case is reported, but many of them follow very closely the course of procedure in New York City. In case the attending physician requests that no action be taken, nothing is done except to record the case, as it is not intended to interfere in the relations of physician and patient where the physician assumes the responsibility. If, however, the case is in a tenement house where close contact endangers other people, or if the physician does not request that nothing be done, the health department inspects the place and takes pains to see that proper sanitary rules are observed, and that the patient and others are informed as to what precautions are to be taken to prevent infection. If the patient is unable of himself to secure proper food or proper nursing, measures are taken to provide the necessary care and nourishment. A report of the removal of any patient to another dwelling is required, and upon such removal, or upon the death of the patient, disinfection of the premises is insisted on.

Enforced in this manner, with due regard to the relation of the physician who assumes the responsibility in all private cases, but supplementing and making up for any lack of medical attention or any carelessness where others are endangered, it has been found that there is no reasonable objection to such a regulation. Dr. Hermann M. Biggs, who for years has been the chief medical officer of the Department of Health of New York City, says:

"The notification of a case of tuberculosis does not require any action on the part of the authorities, if it seems reasonable to assume that such action is unnecessary. The very fact that tuberculosis is notified by the attending physician as a communicable disease has the greatest educational value, and justifies the assumption in those instances in which the case is under the supervision of a private physician that reasonable and necessary precautions for the protection of others will be taken.

". . . Experience has shown that the obstacles are largely imaginary; that the harmful results which were predicted as certain to follow have failed to materialize."—*Medical News*, February 20, 1904.

It is because of this extended experience in New York City, which is confirmed by that of other cities which have since adopted similar laws, that the sentiment in favor of such regulations in the cities of the United States is growing so rapidly.

In this inquiry but two instances were found in which any hardship had been suffered by the patient on account of lack of judgment on the part of inspectors of the health department, but in order to prevent this it is important that the law be worded properly. From a study of all laws obtained from the different cities, Mr. Baldwin suggests a bill which should be submitted for the passage in such State legislatures which have not yet any provision for compulsory notification of tuberculosis cases. (This bill is reproduced in the Appendix, p. 811, as it may serve as a guide to physicians desiring to promulgate such a law in their respective States.)

Mr. Baldwin concluded his very instructive article with the following significant phrase:

From all this it will be seen that the growing knowledge of the nature of tuberculosis, and the increasing interest taken in the subject, are having their influence in adding to the number of cities requiring compulsory reports and registration of all cases of tuberculosis, and that the wisdom of what is logically the first step to be taken in the control of the disease is confirmed by experience, where it has been attempted in the proper manner.

All communications referring to a patient's disease, in which his name and address are given, should be made in closed letters and never sent by postal card. A number of health boards use postal cards giving

full name and address and stating whether a small or large number or no bacilli have been found. In small communities, as well as in large ones, such open communications may prove disastrous to the unfortunate patient concerning whom the report has been made.

Care of Tuberculous Federal Employees.—The care of the tuberculous must, of course, also include the tuberculous individuals in the army and navy, and other tuberculous government employees, inmates of prisons, reformatories, insane asylums, etc. The tuberculous sailors of the United States Marine Hospital Service are taken care of at Fort Stanton, N. M., the tuberculous men of the United States Navy are sent to the United States Naval Hospital at New Fort Lyon, Col., and the tuberculous soldiers are cared for at Fort Bayard, N. M., now transformed into a sanatorium.

To assure a timely diagnosis in the cases of our sailors and soldiers the writer would suggest a periodical examination, at least every six months, of the chest of every soldier and sailor. Only by such methods will it be possible to weed out from the barracks or the war ships the tuberculous individuals and give them the best possible chance for an early recovery.

President Roosevelt issued the first executive order with a view to preventing the spread of tuberculosis among the employees of the Government (especially of post offices) in February, 1906. The recent discovery of five cases of tuberculosis among the employees of the Insular Bureau of the War Department in the State, War, and Navy Building, seems to indicate the necessity of such periodic examinations of all government employees, in order that these patients may be treated at the right time and in the right place and before it is too late.

Care of Tuberculous Insane.—Dr. A. E. McDonald, Director of the Manhattan State Hospital for the Insane for the Directory of Institutions and Societies Dealing with Tuberculosis in the United States, says, in part:

> It is not proposed to follow here in detail the history of the camp for tuberculous patients. Neither the purpose of this communication nor the limitation as to space will permit of it, and the reader who may desire further information in that direction must be referred to the annual printed reports of the hospital and to special articles by members of the hospital staff which have, from time to time, appeared in the *Journal of Insanity* and other professional publications. It must suffice to summarize results. The isolation of the tuberculous patients has reduced to a minimum the danger of infection of other patients and of employees. The patients themselves have suffered no injury or hardship, but have, on the contrary, been unmistakably benefited. This is shown, among other

ways, by the decrease in the death-rate from pulmonary tuberculosis, both absolute and relative, and by a marked general increase in bodily weight, amounting in the case of one patient to an actual doubling of weight—from 83 to 166 pounds—in fourteen months of camp residence.

Mental improvement has, as a general rule, been the concomitant of the physical, not only among the patients in the Tuberculosis Camp, but also in the others, and in the former class this has been somewhat of an anomaly. My experience, and I think that of others, has been that when phthisis and insanity coexist they are apt to alternate as to the prominence of their several manifestations—the mental symptoms being more pronounced while the physical are in abeyance, and *vice versa*. Under the tent treatment we have found a general disposition toward accord in the manifestations, improvement in both respects proceeding concurrently, and some of the discharges from the hospitals which gave most satisfaction to us at the time, and most assurance for the patient's future, were of inmates of the Tuberculosis Camp.

The mental improvement, even in cases where recovery was not to be looked for, has been a gratifying feature of the camp experiment, and depending largely, as it has, upon the patient's satisfaction with his new surroundings, has served to dispel one of the doubts with which the experiment was undertaken. It was apprehended that not only might the patients themselves resent their transfer, but that similar objection might come from their relatives and friends, since innovations, even progressive ones, are apt to be frowned upon by those who constitute the majority of the *clientèle* of a public hospital in a cosmopolitan city. Even at the outset, however, the protests, whether from patients or their friends, were surprisingly few, and latterly they have been more apt to arise, if at all, over the patient's return to the buildings when that becomes necessary.

As an interesting incidental fact it may be mentioned that not only the patients, but also the nurses, living in the camp have enjoyed almost complete immunity from other pulmonary diseases. Not a single case of pneumonia has developed in the camp in its existence of over three years, though it caused 131 deaths in the hospital proper in that time. The "common colds" so frequent among their fellows living upon the wards, or in the Attendants' Home, have been unknown among the tent dwellers.

The popular idea that the consumptive is a doomed man unless he can at once abandon home and family and business, and betake himself to some remote region, would seem to be negatived by our Ward's Island experience. So also with the strenuous claims for high altitude. The Ward's Island Camp is but a few feet above the tidewater level, its side is swept in winter by winds of high velocity coming over the ice-bound waters of the rivers and the Sound which surround it, and it suffers as much as, or more than, any other part of the city of New York from the trying changes of temperature and humidity which are so characteristic of its climate. If, in spite of all these drawbacks, what has been done can be done, and that for insane patients, what may not be hoped from the extension of the same methods to the ordinary consumptive of sound

mind, anxious for recovery and capable of giving intelligent assistance in the struggle?

Care of the Tuberculous in Almshouses, Asylums, and Boarding Schools.—Asylums for the aged and crippled, poorhouses, orphan asylums, and boarding schools are very often the seat of numerous early cases of tuberculosis, which, because of a belated diagnosis, finally become centers of infection. In all such institutions sanitary supervision as to proper ventilation and periodical examination of the inmates' chests will be the only means to do away with this danger.

Tuberculosis in Prisons and Reformatories.—Tuberculosis in prisons and reformatories is a subject of vital importance in a crusade against this disease. It was the writer's privilege last year, on invitation of the physicians of the National Prison Congress, to address that gathering on the subject of "The Tuberculosis Problem in Prisons and Reformatories." It would seem, thus, that the medical men in charge of these institutions are fully aware of the importance of the subject. Yet only a few States have made an effort to separate the tuberculous prisoners from the nontuberculous, and fewer yet have undertaken systematically to treat them. It is hoped that State governments will soon act on the suggestions of the prison physicians, who are almost unanimous as to the necessity of segregating and treating the tuberculous inmates in prisons.

In the address above referred to (Knopf, '06) a plea was made not only for the examination of every prisoner committed to a penal institution at the time of his entrance, and periodically afterwards, but also for examination of individuals in detention prisons. As far as could be learned from visits to detention prisons in New York and other States, prisoners who are simply held for trial or are awaiting removal to the penitentiary, are never examined by any physician unless they are quite ill and in actual need of medical attention, or obviously afflicted with consumption. It must be evident that in this way a latent tuberculosis has a chance to develop, for even in the better city prisons the usual overcrowding will render the atmosphere vitiated, particularly in winter. Add to this the lack of exercise and the depressing psychical influence of confinement, nostalgia, and worry, one cannot wonder that prisoners arriving, after sentence, at a penal institution are often found to be tuberculous, some even with very active lesions, while they may have entered the prison of detention seemingly in good health. Again, some may have been a little below par, underfed or weakened by exposure, and as a result have contracted tuberculosis from consumptive fellow prisoners while in jail.

This is not said in disparagement of the heroic attempts made by most of the wardens and physicians to render modern detention prisons

as sanitary as possible. A good example is the well-kept and modernly built principal prison of New York, The Tombs, situated on Center Street, between Leonard and Franklin Streets. But even here one strongly predisposed or already slightly afflicted with pulmonary tuberculosis has a good chance to develop the disease to its full extent. It is impossible, with 400 prisoners comprising the ever-changing prison population of the Tombs, that one single physician could examine all prisoners carefully enough to detect the presence of an incipient tuberculosis. Prisoners awaiting trial stay in the Tombs sometimes six months and longer. They are not occupied with anything. They are allowed to exercise in the open air only once a week and for about an hour and a half. It is well known that many detention prisons are not as hygienically built as this one, and that there exist additional depressing factors in many of them well calculated to further tuberculous diseases.

What can be done to strike at the root of this deficiency in dealing with the tuberculosis problem in prisons? A competent staff of expert diagnosticians should be attached to every detention prison to examine each prisoner for tuberculosis, syphilis, or other infectious diseases. The seeming increase of expense which would thus arise to the community will in the end result in a financial and sanitary benefit to the community at large. Nor is there any reason why the prisoner who has means should not be taxed to defray the expense for a measure from which he himself derives the greatest benefit. If he is himself unknowingly afflicted with tuberculosis, the early recognition may mean to him the saving of his life. If the disease is recognized in one of his fellow prisoners he is protected from contracting it.

If prisoners did have to remain in detention prisons only three or four weeks, the enforced idleness with one hour and a half open-air exercise weekly might not be very injurious; but when their time of staying in the detention prison is longer than that, a physical, mental, and moral deterioration is almost inevitable.

It is at the very beginning of incarceration and enforced idleness that these factors produce the most depressing effects, and if there is any predisposition to tuberculosis it is sure to develop it. Whenever practicable, even detention prisoners should be occupied with something useful and health-sustaining.

Lastly, there should be some arrangement in the detention prison to give the prisoner a sufficient amount of exercise in the open prison court to assure his physical well-being—not weekly, but daily.

It would thus seem that the first step toward the prevention of tuberculosis in penal institutions should be a most careful examination of such individuals, and the weeding out and isolating of all tuber-

culous prisoners detained in jails. The tuberculous patient should remain isolated in the detention prison as well as in the penal institution, and he should be given the benefit of hygienic and dietetic treatment from the first moment he becomes a ward of the State or city.

When the time for his transfer comes, the history card of his disease and the recommendation of the physician should be transmitted with the other papers of the prisoner to the penal institution. After his arrival at the prison, in which he is to stay for some length of time, the physician will decide whether he is able to work or not, and what kind of work might be most conducive to his recovery. There is no gainsaying that the ideal occupation for the tuberculous prisoner is agricultural or garden work.

In a previous communication on prison hygiene as far as it appertains to the prevention of tuberculosis, the writer stated that not only should there be a careful examination of every prisoner for tuberculosis when he enters the prison of detention or the penal institution, but his chest should be reëxamined periodically, at least once every three months. With this periodic examination a very incipient case, which might have escaped detection during the "entrance" examination, is sure to be discovered before the disease has progressed to any considerable extent.

Expectorating, except in proper receptacles placed for that purpose in cells, workshops, chapels, schools, and on the grounds, should be punished by severe disciplinary measures. That there may never be an excuse for violating this rule, there should be provided not only a sufficient number of fixed, elevated, suspended, simple, or self-flushing cuspidors as, or similar to, the ones illustrated in the Appendix, but each prisoner should carry some sort of a pocket flask or receptacle made of metal, glass, or pasteboard, similar to those used in sanatoria for consumptives.

A prison is, perhaps, the only place in the world where spitting regulations can be rigorously enforced, and it is but fair that, if we say to an individual, "Don't spit here and don't spit there," we should give him a chance to spit somewhere when he has an excess of saliva, a cold, etc. With such a measure not only would tuberculosis diminish in prisons, but epidemics of pneumonia and grip would be less to be feared and more easily controlled. It might be recommended as a regulation that every prisoner must hold his hand before his mouth when coughing, whether this coughing spell is followed by expectoration or not. Thus drop-infection—that is to say, the expulsion of bacilli with droplets of saliva—will be avoided, and since the pneumococcus is so very prevalent, even in the mouths of healthy individuals, this precaution may perhaps also tend to the diminution of pneumonia. As an additional measure to prevent drop-infection, it might be well never to

put prisoners too close together at the work tables. Whenever practicable, there should be a distance of three feet between them. It has been demonstrated that at that distance the droplets expelled during coughing fall to the ground.

It goes without saying that the personal and bed linen of the tuberculous prisoner as well as his clothing should be subjected to disinfection regularly. The handkerchiefs of this class of prisoners should consist of squares of cheap muslin, which should be burned after use.

To judge from the appearance of the various kinds of blankets, comforters, and quilts which were lying on the cots in the prisoners' cells in some of the penitentiaries visited by the writer, it seemed that these coverings might become the means of spreading infection, not only of tuberculosis, but of a good many other communicable and contagious diseases. The blankets and comforters are, as a rule, the private property of the prison inmate. He brings these articles with him, or they are given to him by visiting friends, or by fellow prisoners who have been discharged. In most prisons these coverings, as well as the clothing which the prisoner wears on entering the penal institution, are carefully disinfected. The precaution does not, however, suffice to prevent the bed covering from becoming thoroughly infected afterwards, particularly with the germs of tuberculosis. Pulmonary tuberculosis is so insidious in the early stages that the prisoner may have infected his bedclothing long before his disease was discovered by the prison physician, unless, of course, frequent and thorough examinations of all prisoners are in vogue.

To guard against infection which may arise from blankets, comforters, etc., having been soiled by tuberculous sputum or other infectious material, the writer would suggest that after thoroughly disinfecting these articles when they are brought to the prison, they be incased in a covering of light-colored washable material (not necessarily white), as one uses a pillow case. By basting the blanket in its "blanket case" it can be manipulated with as much ease as if uncovered. With comforters and quilts the same method should be pursued. There should be two sets of cases, so that the blankets need not remain uncovered while one case is being washed; thus the blankets need never come in direct contact with the prisoner's body. With such a system, and with the injunction that this washing must be done regularly, one factor of transmitting tuberculosis and other infections from prisoner to prisoner will be done away with.

Even the prisoner who is only suspected of having tuberculosis should have a separate cell, and, as far as possible, the placing of two prisoners in one cell should be avoided.

The bucket system for receiving the dejecta of prisoners during the

night and during the day when confined to their cells, is most deplorable. It is unsanitary in general, and as far as it permits the emanation of odors and gases it is deleterious to the health of the inmate. The individual cell water-closet, with a perfect trap and cover, such as is used, for example, in the New York Tombs and other new prisons, is certainly to be recommended in place of the bucket system.

The more advanced cases of tuberculosis, particularly those with constant fever and in whom there is disintegration and corresponding abundant expectoration of bacilli, should be treated in special wards, and in summer, perhaps, in special tents of the prison hospital.

In view of the probable indifference to hygienic regulations of the inmates of the hospital, and for the purpose of preventing drop-infection, all patients in the more advanced stages must wear a mouth mask. Patients in a number of European hospitals for consumptives are told to make use of such masks in order to protect themselves as well as the other patients. The mask shown in Fig. 36 is known as Professor Fränkel's mouth mask. It is a valuable means to prevent drop-infection, which, with the advanced cases among consumptives, is quite a serious factor in the propagation of the disease. By impregnating the gauze which is held in place by the metallic frame of the mask, with some medicinal substances, the tuberculous prisoner could be made to believe that the instrument was worn for his own personal benefit instead of for the benefit and protection of others, or, as they might think, as a means of marking them as individuals suffering from a contagious disease. Thus, even the humane arguments against the use of such a mask would have no foundation. Where these masks have been used bacilli have been found almost constantly on the gauze. Fränkel's and Moszkowski's experiments have demonstrated the great value of these protective masks, which can easily be disinfected. The gauze should, of course, be changed as often as necessary, but at least two or three times a day, and immediately be burned after removal.

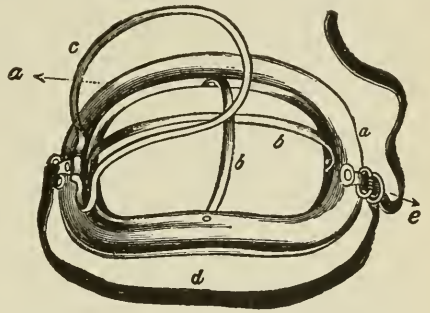

Fig. 136.—B. Fränkel's Mouth Mask for the Prevention of Drop Infection.

For use at the bedside of consumptive prisoners, Seabury & Johnson's well-known square pasteboard cup with metallic frame or Kny-Scheerer's round pasteboard small cuspidor with cover, or their simple metal spit cup, are most suitable. When filled with sputum these paste-

board receptacles and their contents are destroyed by fire. (See Appendix.)

The custom of whitewashing a room in which ordinary and healthy individuals stay but a short time might be considered a hygienic procedure. When, however, this process has been adopted for the sake of doing away with the danger of tuberculosis, its efficiency may be doubted. In case a cell has been previously occupied by a tuberculous prisoner, he has surely infected its walls, if not directly by expectorating on them, he has done so by drop-infection. Whitewashing is well-nigh useless, since dried whitewash is apt to scale off, especially when there are several coats, and it will almost constantly produce a certain amount of dust in a small room like a cell. This becomes irritating to a sensitive lung, and it is not unlikely that it may be an aggravating factor with prisoners who enter the penal institution only slightly tuberculous or predisposed. The new occupant, if at all debilitated, physically or mentally depressed, is strongly exposed to contracting tuberculosis in such an environment. The scales of the new coat of whitewash gradually disintegrate into fine dust, unite with the underlying tuberculous dust, and make an infection by inhalation *par excellence*.

The method of inhaling tuberculous germs from infected walls has been demonstrated again and again, not only inside of prisons, but in the tenement houses of the poor, and even in the apartments of the rich (Flick, '88). Dr. Ransom expressed himself as follows in regard to the delusion that whitewash is a cleaning and disinfecting agent:

> Observation and experiment show that whitewash really promotes the spread of tuberculous disease. The fine scales and floating particles that emanate from the dried whitewash when disturbed not only irritate the bronchial mucous membranes, but they are also carriers of infection to the point irritated.

To remedy the danger arising from whitewashing small cells, the writer would suggest that the whitewash be replaced by oil paint which can be washed off with strong disinfecting fluids. The cells should, of course, never be smaller than 500 to 600 cubic feet, well ventilated, well lighted by natural light in daytime and by electric light at night (gas illumination absorbing too much oxygen). In the Ohio State prison prisoners with sufficient means to pay for having their walls painted instead of whitewashed can avail themselves of this hygienic safeguard. The injustice of such a rule is evident. On the writer's suggestion the painting of all the cells in the Columbus prison has been done since.

As to the general sanitation of prisons as far as it relates to tuberculosis, a prison with all its annexes should be constructed so that there is plenty of light and ventilation, and on a soil that is dry and porous.

To avoid the acquisition of a predisposition or the developing of an incipient case, all prisoners should be given a chance to exercise several times during the day in the open air, even if it is only for a short time, and during that time they must not only be permitted, but should be enjoined, to take deep inhalations, or, better yet, regular respiratory exercises. The exercise in the open air should, however, not be limited to week days. According to the prison regulations now in vogue in most penal institutions, prisoners are confined to their cells not only from the hour of five in the afternoon to six in the morning, but also during almost the entire twenty-four hours of Sundays and holidays, and when a holiday follows a Sunday, or *vice versa*, the prisoners are necessarily locked up in their cells for two successive days. That such close long confinement in a small, ill-ventilated cell must be harmful is self-evident.

In well-conducted prisons the inmates are required to bathe regularly, and their skin is usually in good condition. To the prisoner predisposed to tuberculosis or one whose case is so incipient that constant medical supervision is not necessary, permission for daily cold douches should be given. To this class of prisoners, predisposed or incipient, it seems that it would pay the State to give food containing a little more of the nitrogenous substances and the carbohydrates than the regular prison fare now represents.

One predisposing factor to tuberculosis in prisons, which seems to have been overlooked in most of the reports on the subject, is overworking the prisoners. While it is true that in the majority of prisons the hours of work are rarely more than those of the average free laborers, we must not forget that the free man, laboring eight to ten hours a day, has a relatively better quality of food, the exhilarating influence of freedom of action, and naturally superior hygiene. The writer does not wish to make this statement in the spirit of criticism, but simply to point out the general likelihood of a predisposed individual developing tuberculosis more rapidly under conditions of confinement than when in normal environments.

The writer has visited a number of prisons where the workshops were very badly ventilated, overcrowded with workers, often overheated, and where there should have been dust collectors they were wanting. For example, tobacco workers under the best conditions are prone to tuberculosis. How much more must they be in danger in a prison workshop constantly dust-laden, where there is hardly elbow room and the air is greatly vitiated? Since it is a very common practice for cigarmakers to paste the final leaf with saliva, it must be evident that no prisoner, even slightly afflicted with tuberculosis, should be permitted to make cigars, leaving aside the fact that such conditions are sure to aggravate his disease.

One phase of the subject which appertains rather to the welfare of the community at large is the pardoning of prisoners far advanced in tuberculosis. Whether this practice of restoring the pardoned prisoners to their often poor families is always a wise one is open to question. It is often sad enough that prisoners who have contracted tuberculosis in prison, or whose tuberculosis has been aggravated through prison life, should be discharged at the expiration of their sentence without any regard to where they will go or what they will do. They will invariably constitute a source of infection unless they have been prophylactically trained and are willing to continue to be careful. Prisoners virtually dying from tuberculosis should not be pardoned and sent home unless the authorities are sure that the unfortunate sufferer will not become a burden to his family nor a source of infection.

As to the value of agricultural colonies as a means to employ, treat, and cure tuberculous prisoners in the earlier stages of the disease there can be no doubt. In connection with the care and treatment of advanced tuberculous prisoners the admirable work done at the Texas tuberculosis agricultural colony known as the Wynne State Farm, under the scientific and humane management of Dr. Fowler, should be mentioned. The statistics of four years working of this farm are as follows:

Total number		discharged	34
"	"	pardoned	30
"	"	transferred	37
"	"	died	46
"	"	on hand	33
"	"	treated	180

At the conclusion of Dr. Fowler's interesting report he comments on the statistics as follows:

I will say that the 37 men transferred are virtually cured, and at least one half of those pardoned and discharged were in good physical condition, and the majority on hand are improving. The labor of the 180 men was practically of no value anywhere else in the prison, as most of them had reached an advanced stage of tuberculosis before their reception at the Wynne Farm. The farm is more than self-sustaining, if the expense of guarding the prisoners is deducted. The men all occupy the same building, as they have to be guarded day and night.

From the report it is evident that tuberculosis has been on the decrease in that prison, and there is no doubt that the tuberculous prisoner, cured through the healthful and invigorating agricultural pursuit, will be returned to society after the expiration of his sentence many times a better member of it than he was formerly.

Tuberculosis and Domestic Animals.—Before taking up the subject of combating tuberculosis in domestic animals, and thus preventing a possible infection of human beings, it is but right that, in justice to the still existing controversy whether tuberculosis can be transmitted from animal to man and from man to animal, we give the conclusions at which the majority of American, British, French, and German scientists (the Koch school excluded) [1] have arrived:

1. Bovine tuberculosis may be communicated to human beings, and in such cases it is usually children that are affected.
2. Tuberculosis of other domesticated mammals (hogs, sheep, goats, etc.) may also be communicated to human beings. It is usually, but not always, of the bovine type.
3. The tuberculosis of poultry is not communicable to human beings.
4. Parrots and some other varieties of cage birds may be affected with a type of tuberculosis communicable to human beings.
5. The tuberculosis of human beings, as a rule, is not communicable to cattle, but is communicable to pigs, dogs, and cats. The bacilli in a certain proportion of the cases of human tuberculosis, however, are virulent for cattle and produce in these animals a fatal generalized tuberculosis.
6. Precautions should be taken to protect human beings from animal tuberculosis by a careful inspection of meat-producing animals at the time of slaughter, and of the cows from which milk, cream, and butter are produced (Salmon).[1]

In a book destined particularly to be of help to the general practitioner it would be out of place to give the details regarding diagnosis, hygiene, and treatment appertaining to tuberculosis in animals. On the other hand, it would seem of vital importance that the general practitioner, and particularly the one residing in country districts, should be familiar with the latest, best, and most feasible methods of repressing tuberculosis in domestic animals, for he certainly will be called on, some time or another, as health officer of his community or as an adviser to the Board of Health, for help and suggestions.

Some very concise and practical suggestions are given by Dr. D. E. Salmon in the report which appeared in the *Bulletin*, No. 38, of the Bureau of Animal Industry, the careful perusal of which the

[1] At the British Tuberculosis Congress, in 1901, Professor Robert Koch delivered an address entitled "The Combating of Tuberculosis in the Light of the Experience that has been Gained in the Successful Combating of Other Infectious Diseases." In this address he said that experiments had been made by himself and Professor Schütz, and others of his pupils, which led him to conclude that tuberculosis was not transmitted from the lower animals to man.—"Twentieth Century Practice of Medicine," vol. xxi, p. 781.

writer strongly recommends. It can be obtained by applying to the Bureau.

Supervision of Slaughterhouses.—It must be evident that no effectual prevention of tuberculosis contracted through infected meat is possible without a careful inspection of all animals coming to the slaughterhouses and the condemnation of all diseased ones. This feature of prevention is by no means perfected as yet, and will not be until there are better laws (Federal, State, and municipal) and a better coöperation between the respective State authorities. This latter feature is particularly important to prevent the clandestine transportation of diseased cattle from one State with good bovine laws, which are strictly enforced, to another State with either less good laws or where good laws are not enforced.

Protection against Infection from Tuberculous Milk.—No subject is perhaps more important to the general practitioner, particularly to the one who devotes much attention to diseases of children, than the subject of pure milk. That the procuring of clean, pure milk, free from pathogenic germs, is a very essential feature in the combat of tuberculosis is now generally understood. The battle for pure milk in New York City, which may serve for an example to other cities, dates back to 1842, when Mr. Robert H. Hartley, one of the founders of the New York Association for Improving the Condition of the Poor, wrote what was then said to be the only volume in the English language devoted to the scientific treatment of milk production. In 1850 it was published in more popular form, entitled "The Cow and Dairy," and was a potent factor in the "swill-milk" agitation and reform that followed.

It is due to this association that a milk conference was recently called and a committee, composed of leading sociologists, philanthropists, and physicians, was created. The committee is to be permanent and is to work in coöperation with the Board of Health and the New York County Medical Society, and all those engaged in or related to the production, handling, and distribution of milk. From the first report published we learn that the New York Association for Improving the Condition of the Poor was also instrumental in having the law of 1864 passed, which prohibited the adulteration of milk.

Some two years ago a movement was begun to secure more milk inspectors. In the summer of 1905, at Commissioner Darlington's request, the association furnished the Health Department with an inspector who, from April 1st to August 5th, made 2,900 inspections, examined 3,770 specimens, took 264 samples, and destroyed 6,739 quarts of adulterated milk. Fifty-one arrests for adulteration resulted in the conviction of 47 dealers out of 49 tried. The commissioner also trans-

ferred to milk inspection 150 sanitary officers from other fields for a time.

In 1906 the association assisted in obtaining an appropriation which enabled the Department of Health to double its staff of milk inspectors and coöperate with the *Evening World* in an enthusiastic campaign which led to a marked reduction in infant mortality, saving several hundred lives between July and September.

The following are the most important conclusions and suggestions arrived at by the conference:

Inspection of dairies and creameries is without doubt regarded as of the first importance.

To accomplish this with reasonable speed and thoroughness sixty to eighty inspectors in the country are needed. The milk must be drawn from healthy cows under conditions of cleanliness of animals, milkmen, premises, water, utensils, and milk cans; milk must be immediately cooled to at least 50° F., and so delivered at creameries, where it should be handled in a thoroughly sanitary manner, and further cooled. Inspection must then follow it every step of the way to the consumer, protecting it from contamination and never permitting its temperature to rise at any stage above 50° F.

The expression was unanimous that nothing can render such inspection unnecessary or reduce its importance.

Equally important is it that all cans and bottles shall be cleaned immediately after being emptied, and so sent back clean to the country, where they should be sterilized before being refilled. Closely allied to this is the necessity for improved cans which can be cleaned more easily.

The improvement of conditions in retail stores, while in a great measure covered by "inspection," involves much besides, such as

> New regulations as to construction and handling and conditions in stores, all tending to the final establishment of model milk shops.

Infants' milk depots are at once of the most vital importance, being directly related to infant mortality, and within the possibility of early establishment.

To secure the cleanliness of the vast total milk supply and its proper distribution is a tremendous task; to obtain 10,000 quarts daily of clean milk and place it within the reach of the people, pasteurized or raw, modified, in feeding bottles, with directions from physicians and nurses, as indicated in the report, is no small undertaking, but is within the power of more than one single philanthropist in this city to render possible within a few months.

To secure anything approaching the best results to follow such inspection, improvement in shops, and establishment of infants' milk depots, the education of the people must go forward.

> They must be taught the value of milk as a food and the absolute need of cleanliness in handling after it comes into their hands.
>
> Every social, educational, and philanthropic agency in this city should lend its best aid to intelligent efforts in this direction.

To render possible the accomplishment of these ends, regulations and legislation must be secured—city, State, and Federal.

A constant and unceasing pressure along all these lines, backed by an enlightened public opinion, is necessary to permanent reform.

This report was signed by Committee on Report: Dr. Rowland G. Freeman, as Chairman; Mr. John E. Sayles, as Secretary; Dr. L. Emmett Holt, Dr. Ernest J. Lederle, Dr. Linsly R. Williams, as members of the Committee on Report.

What philanthropy in coöperation with municipal authorities can do may best be seen from the work which has been done by a single philanthropist, Mr. Nathan Straus, during the last fifteen years. There were 2,917,336 bottles and 1,222,048 glasses of milk sold or given away this season. The new building Mr. Straus is erecting at a cost of more than $100,000 will be finished and equipped with a large pasteurization plant this winter, so as to be in full operation next spring. The totals for the fifteen years show the dispensing of 18,710,892 bottles and 10,089,674 glasses of this milk. Mr. Straus's plan has been copied in nearly 400 cities in all parts of the world.

Dr. Goler's ('07) opinion on the regulation of the milk supply of smaller municipalities than that of New York is particularly instructive, and in view of the excellent results obtained in Rochester it may be well worth while to give his conclusions on this most efficient work:

There must be a sufficient number of inspectors, really to inspect, and through such inspections to determine that the applicant for the holder of a license is qualified to produce and distribute milk. To such a one only should a milk license be issued.

1. That adequate inspection may be made, a sufficient number of inspectors must be employed to collect:

a. From each wagon at least one monthly sample for bacteriological and chemical examination.

b. At least once in two months a sample from each store offering milk for sale.

c. Every city dairy and every store to be scored at least quarterly by the inspector on a score card after the plan of those used by the U. S. Department of Agriculture and the Dairy Department at Cornell University.

2. There must be daily inspection of the incoming milk at each railroad station for:

a. Condition and housing of cans and bottles of milk in shipment.

b. Conditions of empty cans reshipped.

c. Temperature of milk.

d. Inspection of railroad samples to guard the retailers against fraud on the part of the wholesalers.

The territory from which the city draws its milk supply must be mapped, the dairies plotted, the roads examined, the railroad facilities noted, and routes laid so that every farm shipping milk to the city may in the beginning be subjected to a systematic inspection once in two months. No milk must be permitted to enter the city until the seal of inspection has been placed on it by the inspector.

When for one reason or another cow's milk of absolute purity and free from tuberculosis germs cannot be obtained, the more extensive use of goat's milk, which seems to be almost always free from tuberculosis germs, should be encouraged. While the goat ordinarily is looked on as a rather unclean animal, as a matter of fact the milch goat may be tubbed and toweled and thus easily made perfectly clean. For children's feeding such cleansing is a common practice in certain parts of Europe.

Housing of the Masses, Good Tenement House Laws and their Strict Enforcement Essential.—An important feature in the prevention of tuberculosis must, of course, always be the proper sanitation of the home, the school, the workshop, the factory, places of amusement and recreation. The problem of housing the masses, particularly in large cities, is too vast to be dealt with in a work of this kind, but the fearful prevalence of tuberculosis in many of the tenement house districts of our large cities demands attention. New York's often-described "lung block" on Cherry and Market Streets, had, ten years ago, a death-rate from tuberculosis of 37.5 per cent, while the death-rate in the city at large was only 21.52 per cent; for the ten years from 1894 to 1904 no less than 291 cases of tuberculosis were reported to the Board of Health from this block, and since the new tenement house law was enacted 200 violations have been filed with the Tenement House Department against these unsanitary dwellings. Yet in spite of this condition, in spite of the Tenement House Commissioner and the men and women interested in the antituberculosis problem, who have pleaded again and again for the destruction of the block and the conversion of it into a park or playground, the lung block still stands because of the political strength of its owners. Are physicians not often lacking in civic duty by not interesting themselves more in public and political life?

The lesson that the lung block teaches is simply that renovation does not pay when tuberculosis in any house or block has become endemic. There are many "lung blocks" in New York and in other large cities of the United States. Every collection of dark, foul, unventilated tenements is a lung block, dealing death to those who, by economic necessity, not from choice, must live there and call these disease-breeding houses by the name of home. Such conditions should make municipal authorities and public-spirited citizens everywhere realize the need of better tenement houses, where the laboring population may have homes with light and air in plenty, in addition to modern improvements, and at the same time pay no more rent than they had been obliged to pay for unsanitary and uncomfortable quarters in old and dilapidated tenement houses.

All the general practitioner can do in this matter is as a citizen to further proper tenement house laws and their enforcement, and as a physician to urge his wealthy clients to help in the building of as many model tenement houses as possible. Viewed even from a purely utilitarian standpoint, it might be stated that money invested in model tenement houses gives to the investor, as a rule, as high and higher percentage than he is apt to receive from other safe investments.

Those desiring information regarding proper tenement house laws are referred to the admirable reports annually issued by the New York Tenement House Department.

Parks and Playgrounds.—Parks and playgrounds have appropriately been called the "lungs" of a city, and the phthisiotherapeutist knows only too well what this phrase signifies. The city that has the greatest number of large and small parks and playgrounds or open-air recreation centers, particularly when they are located within densely crowded districts, will always be able to boast of the lowest mortality rate from tuberculosis and other respiratory diseases. Here again is a chance for the physician to direct into a useful channel the practical philanthropy of a wealthy client who may wish to do something for his fellow men.

In speaking of the importance of playgrounds in the prevention of tuberculosis, one cannot do better than to quote from an address delivered on this subject by Prof. Henry Baird Favill, President of the Chicago Institute, on the occasion of the Playground Conference which was held in Chicago last year:

> It is not at all sufficient that the children be protected during their helpless years from danger, but that they be furnished with sturdy, disease-resisting bodies. The problem of tuberculosis involves a deep conviction as to the principles of living which, even though it can be inculcated in their youth, would be as rapidly eradicated by their contact with their elders, unintelligent and fixed in habit, except their knowledge and im-

pulse can be kept alive by special advantages and inspirations. . . . Protection of the child must be the watchword under which this reform will be achieved. The ideal of a healthy body, the obligation to protect the child in its susceptible years, the willingness to sacrifice for the child in material ways have to come as the foundation for general reorganization.

The scope of the playground movement broadens enormously at this point. To provide generously the open spaces necessary to carry on the work is obviously the first duty. To regard this work when done as an end accomplished is scrupulously to be avoided. To learn to regard the playground as an elementary means to a very great end must be the object of our propaganda.

Public baths, also baths and swimming tanks in schools, must certainly be considered an important factor in the prevention of tuberculosis, particularly when they are located in the crowded tenement house districts of a large city.

Emigration from City to Village.—Before taking up the subject of the sanitation of the home, as far as its internal equipment is related to the prevention of tuberculosis, it is necessary to speak of the unfortunate tendency toward overpopulation in the cities. Physicians, statesmen, and philanthropists who are interested in the solution of the tuberculosis problem, besides working for the better housing of the poor and the creation of special institutions for the treatment of consumptives, have an additional mission to perform. The tide of emigration from village to city should be reversed. If tuberculosis has made its appearance in a family living in a large city, the physician should exert all his influence to induce especially the younger members to migrate to the country and seek outdoor occupations.

Statesmen should protect the interests of the farmer, so that farming will have more attraction to the rising generation than it has had in the last two decades. Philanthropists should aid the statesmen by endowing institutions for instruction in scientific and profitable agriculture, and also by providing healthful amusements, good libraries, and other educational institutions in country districts, thus making living outside of large cities more interesting and attractive to young people. In short, the love of nature and life in the open air should be more cultivated. In the proportion in which this is done tuberculosis will decrease. But in the cities also open-air life should be more encouraged and, after the example of many European cities, outdoor, healthful amusement places should be established for the masses. The recent establishment of outdoor theaters in some of our American cities must be highly commended by all those interested in the antituberculosis crusade.

Creation of Schools of Forestry and the Preservation of Forests.—The creation of schools of forestry in connection with the preservation

and cultivation of forests in many States where a wasteful destruction of trees is now carried on, would give useful and healthful employment to a number of people, as well as render the region more healthful. It would offer attractive careers to young men seeking to overcome hereditary or acquired tendencies to tuberculous diseases. There is no doubt that the preservation of American forests against wanton destruction by greedy speculators and by the too frequent fires would lead to an improvement of the climatic condition of many regions throughout the country.

The question what to do with a patient who is discharged from a sanatorium as a cured or arrested case is an exceedingly difficult one. To allow him to resume his former occupation or to have him return to the unhygienic home environments from which he came means, in many instances, a relapse, if not a new infection. Everybody agrees that outdoor work, such as farming, gardening, surveying, canvassing, driving carriages or wagons, providing not too much lifting of heavy weights is connected with it, would provide the ideal occupations. For women, suitable outdoor employment is harder to find. There is great danger when too much strain is placed on the system of the former invalid. Even in case of the most complete recovery he cannot compete with a perfectly healthy man or woman.

It would seem that the most feasible way to prevent the danger of a relapse, due to the wrong kind of occupation or to a possible overexertion from too heavy work, would be to have the patient live and work, for at least one year, in an institution which might be called an agricultural or horticultural sanatorium farm, where the kind and the amount of work which the recovered patient is allowed to do would be strictly regulated by an experienced medical supervisor.

Experiments in this direction have been made in this country in the Adirondacks, and an interesting article on the subject, under the heading of "The Garden of the Saranac Lake Industrial Settlement," appeared in *Charities and the Commons* of December 7, 1907. The idea of this settlement was thought out by students of the sociologic problems connected with tuberculosis. It was established as an experiment in May, 1907. During six months of its existence, thirty-one persons have had either temporary or continuous employment; twenty of these workers have been men, eleven women. The wages paid range from fifteen to twenty cents an hour. The former occupations of the patients were those of laborer, glassworker, machinist, butcher, carpenter, clothing cutter, piano tuner, bookkeeper, lithographer, stenographer, photographer, typewriter, bookbinder, shoemaker, carriage painter, office boy, lady's maid, saleswoman, dressmaker, lawyer, draughtsman, and teacher. The industries thus far established or tried are

gardening, poultry-raising, leather work, diet kitchen, sewing and mending, and an exchange for the sale of articles made by invalids at their homes. Mrs. William E. D. Scott is the superintendent. The writer of the article above referred to is Curator of the Department of Ornithology at Princeton University, and is himself an enforced resident at Saranac Lake. At the end of nine months he had so far recovered his health as to be able to direct actively much of the outdoor work planned by the organization which is especially devoted at present to truck-gardening and poultry-raising.

In Pennsylvania arrangements are being made by the Department of Health and Charities to send a score of tuberculous patients from the Philadelphia General Hospital to the City Tract at Byberry farm. The change is to be in the nature of an experiment, and if it proves beneficial a greater number of consumptive patients will be removed to Byberry.

Sanitation at Home.—The sanitation of the home and its equipment to prevent tuberculosis is, of course, of vital interest to the phthisiologist. The model tenement home should give to its tenants light rooms, good ventilation, perfect plumbing, proper heating facilities, and reasonable security from fire.

To make the air in homes as fresh, pure, and sanitary as possible is comparatively easy in summer. The windows and doors can be left open so as to make the air inside as fresh as that outside. The greatest difficulty is experienced in winter. Yet physicians should not fail to urge those in their care to renew the air at least several times a day by opening the windows and doors for a few minutes. Against the fear of night air—that nightmare of our ancestors—we should be particularly emphatic.

When there is a tuberculous invalid in the family or one strongly predisposed to the disease, and the family is in moderate circumstances, or for some other reason the patient must be treated at home, the ingenuity of the practitioner will be taxed to the utmost by his desire to install the sanatorium treatment. In the Appendix (VII) there will be seen a number of illustrations, such as sleeping shacks, sleeping verandas, etc. The poorer the people the more difficult is the problem. If the consumptive sufferer is obliged to sleep in the room which serves as a living room for the rest of the family, there will be naturally strong objections in winter to having the window open day and night. It is for this reason that I devised an arrangement which I call a window tent. A brief description may help the general practitioner to have a window tent manufactured if the device cannot be procured in his locality, or if some one in the family has ingenuity and mechanical skill enough to make one.

Window Tent for the Open-air Treatment at Home.—The window tent is an awning which, instead of being placed outside of the window, is attached to the inside of the room. It is so constructed that the air from the room cannot enter or mix with the air in the tent. The patient lying on the bed, which is placed parallel with the window, has

FIG. 137.—WINDOW TENT IN USE. Note celluloid window. (S. A. Knopf.)

his head and shoulders resting in the tent. By following the description closely you will see that the ventilation is as nearly perfect as can be produced with so cheap a device. The tent is placed in the lower half of an American window, but it does not quite fill the lower half of the frame; a space of about three inches is left for the escape of the warm air in the room. By lowering the window the space can be reduced to one inch or less, according to need. On extremely cold and windy nights there need not be left any open space at all above the window frame. The patient's breath will rise to the top of the tent, the form of which aids in the ventilation. The tent is constructed of a series of four frames, made of Bessemer rod suitably formed and furnished with hinged terminals, the hinges operating on a stout hinge pin at each end with suitable circular washers to insure independent and easy action in folding the same, the Bessemer rod being hardened to make a stiff rigid frame to insure its maintaining the original form.

The frame is covered with extra-thick yacht sail twill, properly fitted, and having elongated ends to admit of their being tucked in under

and around the bedding to prevent the cold air from entering the room. The patient enters the bed, and then the tent is lowered over him. Or with the aid of a cord and a little pulley attached to the upper portion of the window, he can manipulate the lowering and raising of the tent himself. Shutters or Venetian blinds, whether they are attached on the inside or on the outside of the window, can be utilized in conjunction with the window tent as a screen to intercept the gaze of the neighbors, and in stormy weather as a protection. The bed can be placed by the window to suit the patient's preference for sleeping on his right or left side, so that he has the air most of the time in his face.

Another advantage of the window tent is that it will not attract attention from the outside. The bed being placed alongside of the

FIG. 138.—WINDOW TENT RAISED, WHEN NOT IN USE. (S. A. Knopf.)

window will be convenient for the majority of the poor who have small rooms. If, however, the bed must be placed at a right angle to the window, this can be arranged as well. A piece of transparent celluloid is placed in the middle portion of the tent to serve as an observation window for the nurse or members of the family to watch the patient if this is necessary. It also serves to make the patient feel less outdoors and more in contact with his family. He can, if he desires, see what is going on in the room. If the window tent must be placed at

a right angle to the window, the observation glass can be put in on the side (see Figs. 137 to 140).

It goes without saying that, as a rule, patients should not smoke; when, in exceptional cases, this can be allowed, the danger of the celluloid window becoming ignited must be impressed upon them and the greatest caution urged. The writer prefers celluloid to ordinary glass for this purpose, because it can easily assume the vaulted form of the rest of the tent, and thus even the slightest possibility of an air-pocket formation is avoided.

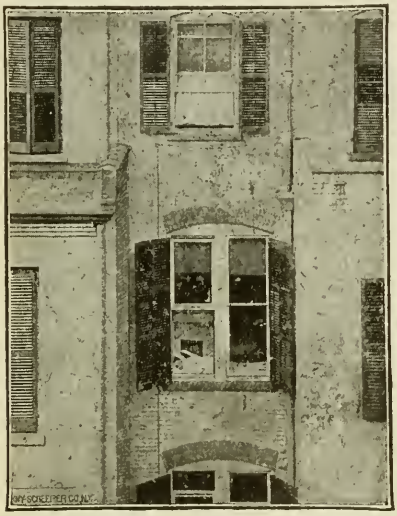

FIG. 139.—WINDOW TENT. View from outside. (S. A. Knopf.)

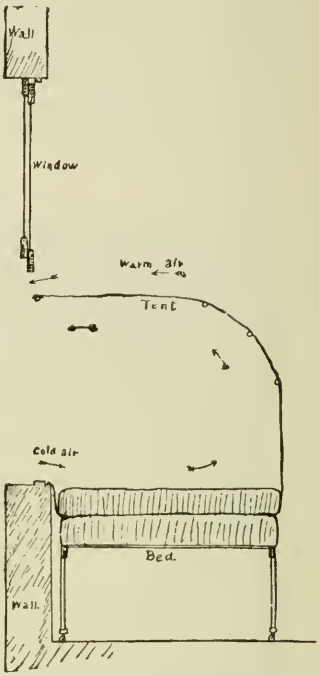

FIG. 140.—DIAGRAM SHOWING VENTILATION OF WINDOW TENT.

If it is necessary to raise the bed to the height of the window sill, it can be done with little expense. If the bed is of iron a few additional inches of iron piping can be attached to the legs by any plumber or one handy with tools; raising a wooden bed can be accomplished with equal facility. If the window tent is to serve the patient only during the night, the tent can be pulled up and the bed moved away from the window during the day and the window closed. Or the tent can be taken from the hooks and put out of the way.

The window tent will, of course, be of greatest value to the consumptive sufferer in winter. If he is feverish, or his stay in bed is advisable, he can spend his entire time in the window tent. If the people are poor, and the room where the consumptive sufferer lies serves as living room for the other members of the family, the fact that the well mem-

bers need not shiver and yet the patient can take his open-air treatment, is of vital importance in many respects. While the room will not be quite as warm as if the window was entirely closed, it will be much warmer than if there was no tent in front of the open window. Laying aside the economic advantages to a poor family when not being obliged to heat more than one room, the patient feels that he does not deprive his loved ones of comfort and warmth, and that he is less a burden and hindrance to their happiness. The other members of the family, on the other hand, feel that they can give the patient all the air he needs, and that he himself need not suffer for their comfort.

In winter the patient's bed must be covered with a sufficient number of blankets to assure his absolute comfort and warmth throughout the night. Still, this covering should not be so heavy as to press down upon the body and make the patient feel uncomfortable or tire him. The tightly woven blanket is a better protection than the loosely woven one. To the poor whose disposal of blankets is, alas! often very limited, it may be valuable advice to tell them to put several layers of newspapers between the coverings. *Outdoor Life* (December, 1905) recommends to have a dozen layers sewed between two layers of flannel. This will certainly make a cheap, light,

FIGS. 141 and 142.—WOOLEN HOODS FOR OUTDOOR SLEEPING.

and warm covering. In extremely cold weather the patient, while sleeping in the window tent, should wear a sweater and protect his head and ears with a woolen cap, shawl, or woolen helmet (see Figs. 141 and 142).

Some patients will complain that the bright light awakens them too early in the morning, and that they have difficulty in going to sleep

again. In such instances I counsel the patient to have some light weight but dark-colored material (such as black lisle thread hose) to put over his eyes. This usually suffices to obviate the inconvenience caused by the bright light.

In the Appendix (VII) there will also be found a number of devices (tents, half-tents, reclining chairs, etc.) to facilitate the rest cure outdoors during the day in the homes of the poor. When there is no garden, no veranda, no roof, which can be utilized for outdoor sleeping, the window tent can also be put into service for the rest cure during the day. The bed is moved away and the reclining chair is put in its place. The latter can be raised to the necessary height by wooden blocks or a platform, and with the aid of blankets and comforters the air from the room can be excluded, and the patient being in front of the open window breathes only outdoor air.

Dry Air and the Danger from Overheated Dwellings.—Many American dwellings and public buildings are heated altogether too much. A temperature of from 65° F. to 68° F. should be sufficient, especially when care is taken that the heat produced by the furnace is not too dry. The excessively dry atmosphere in winter in many public buildings and in many city and country homes often gives rise to nasal catarrhs, a condition which everybody, but especially those suffering from pulmonary diseases, or prone to them, should be anxious to avoid. Besides keeping the water pan in the furnace constantly filled, there should be in the sitting room and sleeping rooms humidifying arrangements.

The humidifier consists of a wooden or metallic box placed with its open side over or before the register. Layers of felt are suspended between two metallic basins containing water; the upper one is the smaller and is placed immediately under the cover of the humidifier, the larger one below. By capillary attraction these layers of felt are kept constantly moist, and the heated air coming from the furnace passing over them is rendered more humid.

More simple evaporating devices, however, such as a vessel filled with water and a cloth suspended above it touching the water so as to produce capillary attraction, will answer the purpose of rendering the atmosphere sufficiently humid.

Experience has proved that we can be perfectly comfortable in a temperature of 65° F., and even a little lower, provided that the relative percentage of moisture is sixty. If this moisture falls to thirty or to twenty per cent, then the dry throat, dry nose, and dry skin are in evidence. A single direct reading hygrometer (Fig. 42), while not over-accurate, will answer for all practical purposes.

Danger from Dry Sweeping.—Dust must, next to the bacilli, be considered the greatest enemy to the tuberculous invalid or to the indi-

vidual predisposed to the disease, for we know that even dust free from pathogenic microörganisms, when inhaled frequently or for a long time, will irritate the respiratory tract and make it more susceptible to the invasion of the tubercle bacillus and other microörganisms.

There is published an excellent little leaflet in four different languages which the Tuberculosis Committee of the Charity Organization Society and also the Health Department have distributed at large. It shows how the danger arising from dusting and sweeping in the home may be reduced to a minimum. These simple and comprehensive rules were suggested to our committee by Prof. T. Mitchell Prudden, of Columbia University.

The most sanitary and ideal method of cleaning any room is, of course, the vacuum-cleaning method, which, it is to be hoped, will some day be cheap enough to be more generally available. For schools, factories, stores, and public buildings this method should be made obligatory.

To sweep unsprinkled streets and raise clouds of dust should be considered a municipal crime. No sidewalks or streets should be swept without having been thoroughly sprinkled. Surface street-car companies should be compelled to sprinkle their tracks at regular intervals in hot and dusty weather. This is done in several cities by cars specially devised for that purpose. Its universal adoption is an urgent necessity.

The Common House Fly as a Propagator of Tuberculosis.—An important factor in the spread of tuberculosis is generally omitted in all leaflets on the subject—that is, the common house fly. It would seem that an item showing the danger of this insect as a distributor of bacilli should be inserted. The abdominal cavities of flies caught in the rooms of consumptives often contain the living tubercle bacilli, so also do the fly specks scraped from the walls and windows in rooms where consumptives live and particularly where their sputum receptacles do not have any covers. The danger from these infected insects is twofold. They die and crumble to dust, which contains the bacilli, and the microörganisms may thus enter the system through the respiratory tract; or the fly may infect some article of food with its feet or excrement, whence the bacilli contained in the deposit find their way into the alimentary tract of man or animal. It is for this reason that we should insist that all sputum receptacles should have covers and never be allowed to remain open.

The fly, however, may not only be a distributor of pathogenic germs, particularly of tubercle bacilli, but it is inimical by its very presence in the sick room. By its interference with sleep in the early morning hours it unquestionably exerts a lowering effect on the vitality of the tuber-

culous invalid. Thus, to any of the circulars on the prevention of tuberculosis one might advantageously add a paragraph relative to the destruction of the house fly, or it may be even better, after the example of the New York Board of Health, to distribute a separate circular to that effect. I copy here the circular relating to this subject recently issued by the Health Department:

Keep the flies away from the sick, especially those ill with contagious diseases. Kill every fly that strays into the sick room. His body is covered with disease germs.

Do not allow decaying material of any sort to accumulate on or near your premises.

All refuse which tends in any way to fermentation, such as bedding, straw, paper waste, and vegetable matter, should be disposed of or covered with lime or kerosene oil.

Keep all receptacles for garbage carefully covered and the cans cleaned or sprinkled with lime or oil.

Keep all stable manure in vault or pit screened or sprinkled with lime or kerosene or other cheap preparation.

See that your sewerage system is in good order, that it does not leak, and is up to date and not exposed to flies.

Pour kerosene into the drains.

Cover food after a meal; burn or bury table refuse.

Screen all food exposed for sale.

Screen all windows and doors, especially the kitchen and dining room.

Burn pyrethrum powder in the house to kill the flies.

Don't forget that if you see flies their breeding place is near-by filth. It may be behind the door, under the table, or in the cuspidor. If there is no dirt and filth there will be no flies.

Prevention of Tuberculosis in the School Child.—In the prevention of tuberculosis school hygiene is most important. The writer has endeavored to point out the great responsibility which we all have, particularly the medical profession, in preventing tuberculosis among the children attending the public schools. If the child has an hereditary predisposition to disease because one or both of his parents has had tuberculosis or syphilis, been afflicted with marked nervous or mental disorder, or addicted to alcoholism, the strain of school life not infrequently suffices to bring out or develop the hereditary taint.

If the home environments of the child are such that it receives either not enough or insufficiently nutritious food, does not get enough sleep or must sleep in an ill-ventilated room, is insufficiently clad and his bodily hygiene generally neglected, or if, as happens too often, it must contribute by its "child labor" toward the support of the family, we have additional predisposing factors to tuberculosis.

As a remedy for existing conditions, the writer suggests that: *First*, the necessity of giving the child more years to play; *second*, more hours of sleep throughout its school term and the abolition of "home studies"; *third*, the training of teachers in the diagnosis of diseases, especially in the objective symptoms of early tuberculosis, to a sufficient extent to facilitate the work of the school physician; *fourth*, small enough classes to enable the teacher to come in close contact with the individual pupil, and classes for the mentally defective and backward; *fifth*, the abolition of child labor, not only in factory, workshop, and in stores, but also at home; and *sixth*, the arranging of the curriculum in all schools so that the mental development is not pushed to the detriment of the physical welfare of the child.

Furthermore to be suggested is the teaching of rational hygiene—physical, mental, and moral—including the teaching of the prevention of tuberculosis, venereal diseases, and alcoholism, to school children according to their age and understanding, by the regular teacher or special teacher or the school physician.

School authorities should inaugurate a thorough course of instruction of school girls, the future wives and mothers of the nation, comprising sanitary and practical housekeeping, including, of course, plain and economic cooking and the art of serving a plain meal appetizingly.

The writer also advises the building, equipment, care, and cleaning of the schoolhouses so as to assure the best possible sanitary conditions for teachers and children and the making of large playgrounds or roof gardens and swimming tanks and baths as indispensable equipments in every school.

Proper breathing exercises, such, for example, as illustrated in Figs. 143 to 146, and outdoor singing, recitation, etc., when weather permits, should prove beneficial, and, whenever possible, instruction in an adjacent school farm or school gardens might form a part of the curriculum.

The following respiratory exercises have, because of their simplicity, been found most efficacious in the experience of the author:

In front of the open window or out of doors assume the position of the military "attention," heels together, body erect, and hands on the sides. With the mouth closed take a deep inspiration (that is, breathe in all the air possible through the nose), and while doing so raise the arms to a horizontal position; remain thus, holding the air inhaled from three to five seconds, and while exhaling (breathing out) bring the arms down to the original position. This act of exhalation, or expiration, should be a little more rapid than the act of inspiration. When the first exercise is thoroughly mastered and has been practiced for several days, one may begin with the second exercise, which is like the first, except that the

upward movement of the arms is continued until the hands meet over the head.

The accompanying illustration shows the positions which are to be taken during these two exercises. Take the same military position of "attention," and then stretch the arms out as in the act of swimming, the backs of the hands touching each other. During the inspiration move the arms outward until they finally meet behind the back. Remain in this position a few seconds, retaining the air, and during exhalation bring the arms forward again. This somewhat difficult exercise can be facilitated and be made more effective by rising on the toes during the act of inhalation, and descending during the act of expiration.

When out of doors one cannot always take these exercises with the movement of the arms without attracting attention; under such conditions raise the shoulders, making a rotary backward movement during

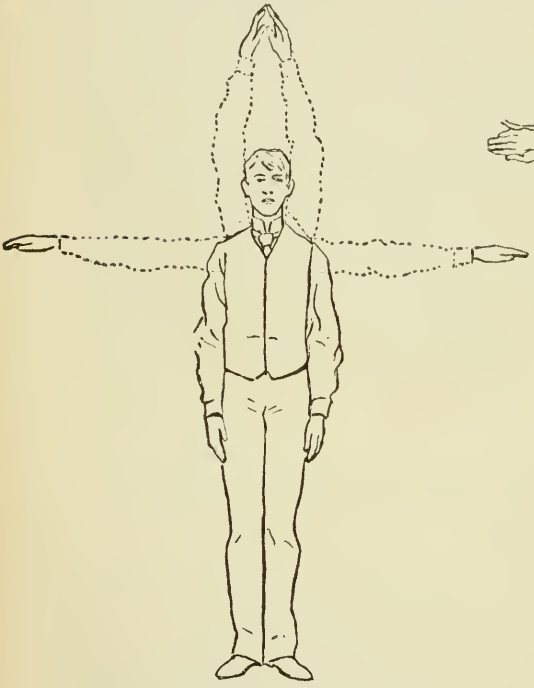

FIG. 143.—FIRST AND SECOND BREATHING EXERCISE.

FIG. 144.—THIRD BREATHING EXERCISE.

the act of inhaling; remain in this position, holding the breath for a few seconds, and then exhale while moving the shoulders forward and downward, assuming again the normal position. This exercise (Fig. 145) can be easily taken while walking, sitting, or riding in the open air.

Young girls and boys, especially those who are predisposed to consumption, often acquire a habit of stooping. To overcome this the fol-

lowing exercise (Fig. 146) is to be recommended: The child makes his best effort to stand straight, places his hands on his hips with the thumbs in front, and then bends slowly backward as far as he can during the act

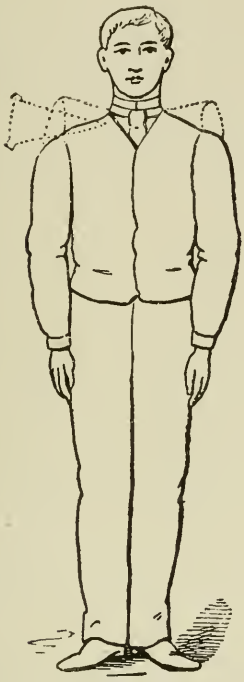

FIG. 145.—BREATHING EXERCISE WITH ROLLING OF SHOULDERS.

FIG. 146.—EXERCISE FOR CHILDREN IN THE HABIT OF STOOPING. (Knopf prize essay.)

of inhaling. He remains in this position for a few seconds, while holding the breath, and then rises again, somewhat more rapidly, during the act of exhalation.

Enough school physicians, especially trained for the work and sufficiently remunerated, should be attached to every public school to assure the exclusion of children afflicted with contagious and communicable diseases, or other physical defects, including bad teeth, with a view of curing or correcting the disease or infirmity through either private or public initiative.

Tuberculous teachers should not be employed in public schools, but if they have contracted tuberculosis in the performance of duty, it is the duty of the municipality to provide for them until their earning capacity is again established.

The establishment of municipal seaside or country school sanatoria

for tuberculous children where some of the tuberculous teachers might also be employed profitably is an urgent necessity.

It would also be wise to add a sufficient number of trained nurses as school nurses, whose duty should be: first, to aid the school physician in his work; second, to visit the homes of the physically, morally, or mentally defective children, in order to learn if home conditions alone are not responsible for the defects in the child. The writer is convinced that by such judicious coöperation of teacher, physician, nurse, and parents, and, if the case demands it, by the help of an organized charity society, many of the underlying causes of the child's troubles can be lastingly remedied.

Substantial school lunches should be furnished by the municipality at a nominal price for those able to pay and gratuitously for the absolutely poor.

The suppression of child labor in factories, coal mines, mills, workshops, stores, and at home is essential if we wish to combat a predisposition to tuberculosis in childhood. The child's organism when enfeebled by labor, by deprivation of sleep and outdoor play, is sure to become an easy prey to the tubercle bacillus, particularly when the underfeeding and unsanitary housing of the child of the poor is added to its misfortunes. There is an equal necessity for a law and the vigorous enforcement of it, whereby mothers will not be forced to work until the very hour of their confinement, nor be obliged to resume work until they have regained the necessary strength to do so after their delivery.

Sanitation of Workshops, Factories, Stores, etc.—The sanitation of factories, workshops, department stores, and other establishments where people congregate to work, should, of course, be made a matter of State and municipal regulation. To guard against direct infection, spitting, except in proper receptacles (elevated spittoons, Proedöhl's factory cuspidor, etc., see Appendix (VII), should be prohibited, and any repeated violation of the antispitting ordinance punished by dismissal.

The public telephone in such places and elsewhere also may serve as a means of the propagation of tuberculosis. An arrangement such as pictured in the Appendix on page 839 might obviate this possible danger. The thin sheet of paper over the transmitter is removed after each time the telephone is used, and the discarded papers collected and burned every evening.

Antituberculosis Work Among Factory Workers.—There is, however, one feature of antituberculosis work in relation to this that can only be carried out by the physician in conjunction with the employer or owner of the factory, workshop, or store. It is the early detection and timely and proper treatment of tuberculosis among employees. To Franklin T. Fulton, of Providence, R. I., belongs the honor of being the

pioneer in this phase of antituberculosis work. The movement was inaugurated by posting on the bulletin boards of the shops official notices stating that the management of the mill or factory had provided, without expense to the employees, a physician to examine anyone who had any suspicion that he might have tuberculosis, emphasizing the fact that in the very beginning the disease can be cured.

Two establishments which took the matter earnestly employed together 5,200 men. From these two plants 34 operatives were examined during about ten months, 18 of whom were found to have tuberculosis and were not under a physician's care. Some of the others had symptoms suggesting the disease, but no definite signs could be detected. It was found that most of these men were living in a very unhygienic way, and their symptoms in several instances quickly disappeared upon their being advised how to live. Altogether, the work in connection with these two establishments has been very satisfactory, and while the number of cases treated has not been very large, Dr. Fulton doubted if there are many sanatoria which show a more marked improvement in as large a percentage of cases and in so short a time. The reason for this he certainly does not believe to be due to any advantage that the home treatment has over the sanatorium treatment, but to the fact that the cases are detected before they reach an advanced stage.

This admirable work of Dr. Fulton deserves the highest praise, and should be brought to the attention of influential and philanthropic employers that his example may be imitated.

Insurance against Tuberculosis.—It is well known that in Germany, owing to the compulsory insurance of every workingman and woman against accidents, old age, and disease, including tuberculosis, the antituberculosis movement has made strides such as could be made in no other country without that provision. These insurance companies are so prosperous, and they have found it of so great a financial advantage to treat their tuberculous policy holders at the right time and at the right place, that they have built themselves a number of tuberculosis sanatoria. Some of these are among the best equipped of the land. The Berlin branch of the "Landesversicherung," for example, established at Belitz one of the finest and most elaborate institutions of its kind, accommodating no less than 300 tuberculous patients.

Aside from all humanitarian considerations, it would seem in the interest of the community at large, the welfare and well-being of the American people as a nation, and in the financial interest of insurance companies, policy holders, and the commonwealth, that the time had come when Americans should imitate the German Invalidity, Diseases, and Old-Age Insurance Companies under State supervision, including, of course, under insurance against disease, all tuberculous affections.

To combat tuberculosis as a disease of the masses successfully, requires the combined action of a wise government (Federal, State, and municipal), well-trained physicians (trained in teaching and practicing prophylaxis in the early diagnosis of pulmonary tuberculosis and modern phthisiotherapy), and an intelligent people, which has learned the value of good health as a prime factor to happiness and realizes that the mutual insurance against accidents, disease, and old age is the safest guard against the possible misfortunes which can come through disease and deformity.

The writer closes this contribution on public measures in the prophylaxis of tuberculosis with a fervent appeal to the Government to take steps which will place federal regulation of public health on a par with that of the leading governments of Europe. Germany has its ministry for medical affairs, with a cabinet officer at the head, and with the highest medical authorities connected with the Imperial Office of Health ("Reichsgesundheitsamt"). France has its "Conseil supérieur de santé," equivalent in importance and power to the Reichsgesundheitsamt of Germany. Our Republic should have a similar office to guard the health of the nation.

The Committee of One Hundred, appointed by Section One of the American Association for the Advancement of Science, has been empowered to work for Federal regulation of public health. The time for it seems to be ripe, and what the creation of such a department or bureau of health [1] would mean for the welfare of the people of this country in general, and particularly regarding the combating of tuberculosis, may best be realized by the following extract from an address delivered by President Roosevelt in Provincetown:

I also hope that there will be legislation increasing the power of the national Government to deal with certain matters concerning the health of our people everywhere; the Federal authorities, for instance, should join with all the State authorities in warring against the dreadful scourge of tuberculosis. I hope to see the national Government stand abreast of the foremost State governments.

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[1] This department of health is not intended to encroach on the fields of the State boards of health. The thought is rather to arouse the State health boards to redoubled activity. One method of accomplishing this is to make the city of Washington, over which the Federal Government has full power, a model city in hygiene (Irving Fisher, "Federal Organization of Health," *Trans. International Cong. Tuberculosis*, Washington, 1908).

ADDENDA

Summary of Public Measures in Prophylaxis of Tuberculosis, Presented at the International Congress held in Washington, D. C.

Economic Meaning of Tuberculosis.—Some interesting new calculations have been presented which may prove helpful in stimulating interest in preventive efforts against the disease. V. C. Vaughan figured that from 200,000 to 250,000 inhabitants of this country die annually of tuberculosis. Taking only the lower estimate, it may be calculated that two thirds or three fourths of these die between the ages of eighteen and forty-five—that is to say, at a time of life when the earning capacity is greatest. Estimating, with Darlington, the value of a single individual during the prime of his life at only $1,500, and taking again the lower estimate of two thirds and not the higher estimate of three fourths, the economic loss which accrues to the United States through the untimely death of these 100,000 people is no less than $150,000,000 annually.

Another calculation of the cost of tuberculosis in the United States and its reduction was presented by Irving Fisher. He estimates the death-rate from tuberculosis in all its forms in the United States at 164 per 100,000 of population and the number of deaths in 1906 as 138,000, and he concludes that at this rate, of those now living in the United States, 5,000,000 people will die of tuberculosis. The average age at death for males is 37.6 years; for females, 33.4 years. The "expectation of life" lost (though estimated on a specially high mortality rate) is at least twenty-four years, of which at least seventeen fall in the working period. The average period of disability preceding death from tuberculosis exceeds three years, of which the latter half is a period of total disability. "The money cost of tuberculosis, including capitalized earning power lost by death, exceeds $8,000 per death. The total cost in the United States exceeds $1,100,000,000 per annum. Of this cost about two fifths, or over $440,000,000 per annum, falls on others than the consumptive. An effort to reduce the mortality by one fourth would be worth, if necessary, an investment of $5,500,000,000. The cost of treating patients at sanatoria is repaid many times over in lengthened working lives. The erection of isolation hospitals for incurables is probably the most profitable method at present of reducing the cost of tuberculosis."

Raising of Funds for Tuberculosis Propaganda.—A practical suggestion toward this end, as well as for the creation of general interest in tuberculosis, is contained in a report by Miss Clara E. Dyar of a scheme employed in Detroit. By this it was possible to raise in a single day

$11,000 for the local Society for the Prevention and Relief of Tuberculosis. Badges representing a blue star on pasteboard were sold throughout the city for ten cents each. Great eagerness was manifested by people of all ages and in all classes, and particularly by school children, to buy and wear the blue-star badges on that day. Collection stations where the blue star was for sale had been established in the principal office buildings, shops, hotels, and factories.

Special Dispensaries.—The importance of tuberculosis dispensaries was strongly emphasized, especially by Dr. R. W. Philip, of Edinburgh, the father of the tuberculosis dispensary idea, and Professor Calmette, the pioneer of tuberculosis dispensary work in France. Philip's terse but very comprehensive definition of such a dispensary may be here quoted. " It is a central institution devoted to the guidance, supervision, and assistance of the tuberculous poor. An information bureau. A clearing house. A center for the supervision of home treatment. The connecting link or knot that completes the chain of other undertakings for the prevention of tuberculosis."

For Calmette the preventorium or supporting dispensary is the essential instrument of social preservation against tuberculosis. It does not treat patients medically, that function belonging to sanatoria, hospitals, and medical polyclinics. Its mission is to locate, attract, and keep under supervision those among the very poor who are peculiarly exposed to tuberculous infection and those who are already affected. It selects patients suitable for sanatorium treatment; takes charge of children that are menaced or already attacked by the disease, promoting their proper treatment and cure in the country or in seaside establishments. Patients dangerous to their surroundings are sent to isolation hospitals. Dwellings are disinfected and contaminated linen sterilized and washed. Spit cups and antiseptics are distributed.

What large amount of work can be done by tuberculosis dispensaries with judicious management was well brought out by Alexander M. Wilson in his report of the work of the Chicago Tuberculosis Institute, which maintains seven special dispensaries in various districts of the city, supplying a nurse to each clinic, and through its central office coördinating the work of the dispensaries, thus preventing duplication. In less than seven months 1,400 examinations were made.

Compulsory Examination of Children.—The importance of this was forcibly presented by Baumel. He suggests the thorough semiannual medical examination of every child in orphan asylums, kindergartens, nurseries, and schools. He furthermore urges that uniform reports and certificates be transmitted to other institutions to which the child will go, or be handed to the child at the end of the school year. Finally, he very pertinently points out the necessity of having the tuberculous

children treated in institutions when the parents cannot have them properly cared for at home. It goes without saying that the children's teeth and ears should be included and attended to if found diseased, a point which was also insisted upon by Woodbury. Finding that ninety-six per cent of school children have decayed teeth, he believes that instruction of school children in dental hygiene is of paramount importance in the prevention of tuberculosis.

Day and Night Camps.—Although these camps are at present primarily intended for treatment, reference to the reports presented may be made here, because of their possible adaptation to preventive purposes. A number of day camps are now in operation in various American cities. Especially important and gratifying is the work of the branches of the Red Cross Society, through whose instrumentality day camps in Washington, Schenectady, Albany, and Buffalo have been established. The New York branch is now coöperating with the authorities of the Medical Department of the Columbia University to establish a day camp on the roof of the Vanderbilt Clinic in the city of New York.

W. C. White presented his conception of a night camp. He suggests that for many tuberculous patients the night camp would be most valuable and productive of a great deal of good especially for those needing supervision or for those who cannot get proper care where they live. He distinguishes the three following groups of patients, for many of which the night camp he believes is the "reasonable and most valuable scheme": I. Those still working, not conscious of their lesion, with (*a*) open, (*b*) closed active, and (*c*) healed tuberculosis. II. Those still working, conscious of their lesion, who from their existing social condition are compelled to work. III. Those not working, conscious of their lesion, yet able to work four to eight hours daily—(*a*) old sanatorium cases, (*b*) home-arrested cases.

Administrative Control.—Biggs reported in detail on this subject, and was able to state that "at the present time there is no other city in the world in which the health authorities have so thoroughly organized the tuberculosis campaign as in the city of New York." R. Koch's emphatic indorsement of the New York methods, which are in detail described in the text, deserves mention.

Naval and Military Prophylaxis.—Kirsch (German navy) pointed out that in order to avoid the more frequent diseases of the respiratory organs in the navy, due to climatic changes, the cut of the uniform should be modified so as to afford better protection to the throat and chest. He suggests also that the men whose services keep them below should be brought on deck every day and put through a drill of gymnastic exercises.

Saar (German army) suggests, as guiding principles in the preven-

tion of tuberculosis in the German army: (1) Refusal of recruits suspected of tuberculosis. Positive signs of tuberculosis or a history of a former illness of a suspected tuberculous nature, or an inferior physique (habitus paralyticus, thorax pyriformis, floating tenth rib), to be regarded as a cause for rejection. (2) Recruits suspected of tuberculosis having been enlisted, should be carefully examined (X-ray, subcutaneous and conjunctival tuberculin tests), and if found tuberculous should be at once discharged. (3) Recruits who steadily lose weight should be carefully examined and eventually be kept under observation in the hospital. (4) Tuberculous soldiers should be kept in hospitals until the time of their discharge from the army. They should be treated in special tuberculosis wards.

He recommends also for the systematic prevention of dust the treating of the floors of offices and barracks with a dust-binding oil (dustless oil, Westrumit). Furthermore, the hardening of the men by means of regular douching, the introduction of "naked gymnastics" in the morning after rising, the establishment of light and sun baths in the open air. Rather radical seems his recommendation that if a noncommissioned officer desires to marry, he should be obliged to furnish a medical certificate of his prospective bride, and also that those serving in the canteen must prove that they are free from tuberculosis.

Prison Prophylaxis.—To this not sufficiently considered problem J. B. Ransom made an authoritative contribution. He concluded as a result of his observations that the large percentage of tuberculous cases in prisons would indicate tuberculosis to be more or less closely allied to crime. He considers the tuberculous prisoner to represent one of the greatest physical menaces to the general social order, insisting on the necessity for a law making mandatory the examination of every prisoner admitted to a penal institution. The experience at Clinton prison illustrates the advantageous results obtainable from special treatment of the tuberculous incarcerated criminal. The death-rate from tuberculosis during the past fifteen years shows a decrease of seventy-one per cent in the prisons of New York. He advocates also a closer study of the disease in prisons where most satisfactory opportunities for prolonged experiment and study are offered.

Prostitution.—A study of its relation to tuberculosis was reported on by J. Willoughby Irwin. An examination of 213 prostitutes showed 82 tuberculous—63 in the first, 18 in the second, and 1 in the third stage (Turban). He believes that it is not beyond the range of possibility that they acquired, or at least some of them acquired, the disease in their intercourse with men having tuberculosis.

Children's School Farms.—Children's school farms, such as are conducted in New York under the admirable directorship of Mrs. Henry

Parsons, should be multiplied, especially in large, but also in small, cities. Such farms, when located in congested districts, do both preventive and constructive work. Children predisposed to tuberculosis are given an opportunity to spend the greater part of the day doing gardening work, learning to love outdoor life and outdoor pursuits, this being of the greatest advantage to their future physical welfare. Mrs. Parson's report made on this subject is full of practical suggestions. She very justly says: "Such gardens, conveniently located throughout the city, would accommodate thousands of such children for six or eight months in the year, year after year, in comparison with the few that can be sent to the seashore, mountain, or sanatoria for short stays. The possibility exists of teaching hygiene within the children's comprehension, by simple experiments with plants in their own plots which will lead them to see why fresh air, cleanliness, and sunshine are absolutely necessary to life and vigor and which will lead them to demand such surroundings in their own homes."

Trained Nurses.—The social significance and educational possibilities of the nurses' work in the homes of the poor and rich was dwelt on by Miss Lillian D. Wald. She described the comprehensive organization of State tuberculosis work in Pennsylvania under State Commissioner Dr. Dixon, with nurses and adjuncts in county centers and State sanatoria; also the "follow-up" work of hospital and dispensary patients, including instruction, interpretation, sending to suitable hospital and dispensary, the procuring of appropriate employment, etc., and working for the development of special care of children in public schools. The hospital training schools for nurses give two or three years' education, technically and morally—an excellent preparation. They are drilling the "soldiers in the field," and always exercise the most careful selection of the graduates. The social significance lies in the ability of these "soldiers" to care for the individual victims and to throw light upon the whole subject and the multiple social questions involved.

Public Schools, Colleges, etc.—Luther H. Gulick insisted on the importance of attacking the tuberculosis problem through the agency of the public schools, which is indicated by the fact that ten out of eleven of all the children of the United States come under the jurisdiction of the public-school system for approximately seven years—namely, from seven to fourteen.

G. A. Heron gave an interesting report of the work done in England. Special instruction in elementary hygiene is given throughout the United Kingdom to prospective teachers in the training colleges. The course of training, however, is so adapted as to avoid even the semblance of turning out teachers who might imagine themselves to be specialists in hygiene. The object of it all is to endeavor to secure for the school

a teacher who is "able to appreciate the conditions, both mental and physical, which unfit a child for school work," and who is so trained that he would be likely to find children who failed to acquit themselves creditably, not because of unwillingness to work, but because of some physical defect or incapacity.

William Harmon Norton advocated lectures on tuberculosis in colleges and university extension courses. He very pertinently pointed out that by so doing hundreds of thousands of young men and women who go out from college to become citizens of exceptional influence in their communities are enlisted in antituberculosis work.

Hygienic instruction in schools was also discussed by H. B. Jacobs, who closed his interesting communication with the significant words: "Never will the suppression of the preventable diseases (including tuberculosis) be secured until the coming generation, rather than the passing one, is instructed in the proper methods to be pursued."

Insurance of Workingmen against Sickness.—The new Hungarian law relating to insurance of workingmen is, according to Johannes Bartha's communication, doing, and is destined to do, even greater work in the prevention of tuberculosis than the German insurance companies. The municipal regulations adopted against tuberculosis in the Freistadt Kolozovar, East Hungary, has accomplished the following objects with the aid of the insurance companies: The recent revision of the building regulations improving the living conditions of the masses, the early closing of saloons, antispitting regulations, the prohibition to shake out dust cloths on the street. Furthermore, provisions must be brought to market in absolutely clean vessels, baskets, etc. Fruits, pastry, etc., must be protected from flies; confectionery may be exposed for sale only in cases covered with tightly fitting glass lids, and customers are not permitted to finger the wares for the purpose of making a selection. Wise abattoir regulations. Rooms occupied by persons who died of tuberculosis, their bedding, and the clothing used by them are disinfected by the city.

Resolutions.—The following resolutions were adopted by the Congress, and they reflect the new prominence given to the social aspects of the tuberculosis problem, of which the establishment for the first time of a section devoted entirely to those aspects was a most gratifying manifestation. It was resolved:

1. That the attention of State and central governments be called to the importance of proper laws for the obligatory notification, by medical attendants, to the proper health authorities, of all cases of tuberculosis coming to their notice, and for the registration of such cases, in order to enable the health authorities to put in operation adequate measures for the prevention of the disease.

2. That the utmost efforts should be continued in the struggle against

tuberculosis to prevent the conveyance from man to man of tuberculous infection as the most important source of the disease.

3. That preventive measures be continued against bovine tuberculosis, and that the possibility of the propagation of this to man be recognized.

4. That we urge upon the public and upon all governments (*a*) the establishment of hospitals for the treatment of advanced cases of tuberculosis, (*b*) the establishment of sanatoria for curable cases of tuberculosis, (*c*) the establishment of dispensaries, day camps, and night camps for ambulant cases of tuberculosis which cannot enter hospitals or sanatoria.

5. That this Congress indorses such well-considered legislation for the regulation of factories and workshops, the abolition of premature and injurious labor of women and children, and the securing of sanitary dwellings, as will increase the resisting power of the community to tuberculosis and other diseases.

6. That this Congress indorses and recommends the establishment of playgrounds as an important means of preventing tuberculosis through their influence upon health and resistance to disease.

7. That instruction in personal and school hygiene should be given in all schools for the professional training of teachers.

8. That whenever possible, such instruction in elementary hygiene should be intrusted to properly qualified medical instructors.

9. That colleges and universities should be urged to establish courses in hygiene and sanitation, and also to include these subjects among their entrance requirements, in order to stimulate useful elementary instruction in the lower schools.

PART V

TREATMENT

INTRODUCTION

By EDWARD L. TRUDEAU

No generally accepted treatment of pulmonary tuberculosis, beyond the climatic cure, can be said to have existed before Brehmer, in 1859, demonstrated by his sanatorium methods the great value of regulation of the details of the patient's daily life, and instituted the now generally accepted and universally practiced open-air method, in which fresh air, rest, and careful alimentation, with or without specially favorable climatic conditions, are the main factors utilized. For the first fifteen years Brehmer's teachings made but little impression, but during the following twenty years the open-air treatment, whether in or outside of a sanatorium, whether under favorable or unfavorable climatic conditions, has been generally accepted and gradually adopted all over the world as giving the best results in the management of all forms of tuberculosis.

At present, life in the open air and generous alimentation are universally recommended, but the great value of absolute rest while symptoms of activity are present, and relative rest at all times, as tending to limit autotoxemia, and the imperative need of the regulation of the daily life for many months at a time, can as yet hardly be said to be generally appreciated, except by specialists and sanatorium physicians. The exact value of climate is still a disputed subject, but it is difficult to understand why climate should be disregarded entirely while all other factors which go to make up a favorable environment for the patient are insisted on. No doubt good results could be and are obtained without any specially favorable climatic influences, but it seems hardly rational to insist on the value of the minutest details of the patient's surroundings and habits of life, and deny absolutely any influence of climate as a factor in securing the most favorable environment obtainable for the patient.

The modern and now generally accepted treatment of tuberculosis by the open-air method aims simply at bringing the patient's general health to the highest possible standard, thus developing the natural defensive resources of the individual, and rendering the soil as unfavorable as possible for the growth and spread of the tubercle bacillus through the system. Successful as this treatment is in many cases, especially where

the disease is detected in its incipiency or is not of too acute a type, it naturally has its limitations, and from a condition of absolute hopelessness and pessimism as to the cure of tuberculosis, the public and the profession are now in danger of forgetting the persistence and relapsing nature of tuberculosis, of exaggerating what can be accomplished by a few months of favorable environment, of underestimating the limitations of the open-air method, and especially the time required to obtain permanent results.

The arrest or cure of pulmonary tuberculosis by the sanatorium and open-air method requires time, and produces too often but a relative cure, which in a great many cases is maintained only if the patient can return to a mode of life and surroundings which make but little demand on his resisting powers. That a patient whose disease has been arrested in a sanatorium is not fitted to return at once to the trying conditions of life which the modern struggle for existence so often renders necessary, is gradually becoming apparent.

What is true in the treatment of pulmonary tuberculosis is equally true in the treatment of all other tuberculous manifestations in the body. The so-called surgical forms of tuberculosis, where the disease attacks the bones, joints, or skin, are best treated by the hygienic, dietetic, open-air method, in or outside of sanatoria, with or without special climatic advantages, but with the addition of conservative surgical measures.

If the good results obtainable by the sanatorium and open-air method could be made permanent—that is, if a certain degree of immunity to relapse could be obtained by any method—the work of such institutions would be much more encouraging. The future outlook for progress in the treatment of this disease, as for all other chronic bacterial infections, would seem to be in the discovery of some specific method of limiting the ravages of the bacteria in the living organism, and the light which experimental medicine during the past twenty years has been shedding on the mechanism of infectious diseases, would indicate that success is most likely to be attained by the discovery of some safe method of producing artificial immunity by the inoculation of bacterial vaccines.

It has taken many years of tireless experimentation to demonstrate the possibility of producing any appreciable degree of artificial immunity to tuberculosis in animals. With this advance the names of Koch and Behring in Germany, McFadyean, Wright, and Douglass in England, de Schweinitz, Trudeau, Pearson, and Gilliland in this country, are closely connected. Koch's discovery of tuberculin, and his application of this substance to the treatment of tuberculosis, mark an era in the specific treatment of this disease. The failures and disasters which followed his announcement and brought tuberculin into such disrepute, were evidently due in a great measure to our ignorance of the principles

of artificial immunization, to faulty methods, and to a lack of appreciation of the extreme toxicity of this most powerful agent.

Of late, with improved methods of application, with a better appreciation of the potency and action of tuberculosis toxins, some clinicians are reporting more encouraging results in the therapeutic use of the various tuberculins. The work of Wright and Douglass on the opsonins, and the relation of the opsonic index to artificial immunization by tuberculosis vaccine, and Professor von Behring's extensive labors on the production of artificial immunity in cattle, indicate that the future of the specific treatment of tuberculosis in man by some immunizing method is full of promise. The prevention of tuberculosis can be advanced by nothing so surely and rapidly as by a successful specific method of curing the disease. When science shall have given us such a method, the control of tuberculosis, with all it means to mankind, will be near at hand.

CHAPTER I

SPECIFIC TREATMENT

By LAWRASON BROWN

HISTORICAL INTRODUCTION

The discovery of the tubercle bacillus was quickly followed by many attempts to destroy it in the tissues of the infected organism by the administration of various substances found to kill it *in vitro*. The literature of this period abounds in reports of attempts of this kind, and many substances were recommended which, if used in sufficient strength, would have killed the host as quickly as the parasite. These so-called "false specifics" will be discussed elsewhere.

The study of the pathology of the disease showed that it was impossible in any case to attack the germ in the midst of caseous matter or in old tuberculous foci where there were no or very few blood-vessels. This, however, is no argument against the use of any substance that can be borne by the blood in such strength that it will kill or weaken the tubercle bacillus and not injure the tissues, for the tubercle bacilli in old tuberculous foci are of no danger to the body unless they escape into the blood or lymph stream, where such substances could speedily attack them. While such a body has not been and is not likely to be found, the whole subject of artificial or acquired immunity rests anatomically on this basis.

However this may be, chemistry has long been called on to furnish new agents for use in the treatment of tuberculosis, and it must be acknowledged that it has been overworked. Since the discovery of the tubercle bacillus we have had a means of testing the germicides experimentally, and none has proved of any value in treatment.

The excellent results obtained by the hygienic-dietetic treatment of tuberculosis is now acknowledged by all, but few realize that its discoverer (Brehmer) attributed for a long time its beneficial influence to some specific property connected with certain climates, or "immune zones." The idea of "specific climates" has long since given place in discussion to the question of the value of "climate," but the "specific" value of high altitudes is still recognized by the use of the pneumatic

cabinet, and more recently by the advocacy of balloon ascensions. There is little to uphold these views.

Robert Koch, in 1890 ('90, A and B; '91, A and B), announced that he had discovered in tuberculin a cure for tuberculosis. Having noted that tuberculous and healthy animals react very differently to a subcutaneous injection of living virulent tubercle bacilli, he was led to the discovery of tuberculin. The first form he experimented with was a non-concentrated broth filtrate from a culture of human tubercle bacillus, now known as bouillon filtré (Denys). Koch considered this a weak tuberculin, and discarded it for the stronger, *original tuberculin* (O. T.). He advised the use of the original tuberculin only in early cases, with a first dose of 1 mgm., which should be repeated until there was no longer any reaction. Then 2 mgm. should be given in the same way, and so on. He believed it so acted on the circulation of the parts about the foci that the diseased tissue died and softened, or was discharged *in toto*. A failure of reaction was, therefore, due to the destruction and lack of tuberculous tissue, and so healing he believed was accomplished. The avoidance of reactions was not mentioned. This view has long since been given up by Koch.

Notwithstanding these cautions, tuberculin was administered to all sorts of cases, and many a poor, far-advanced consumptive was hurried to his grave. A patient, for instance, was given tuberculin and reacted to 104° F. on the following day, when he received a second dose with similar results. This was continued in some cases until death ensued. A few observers protested (Guttman and Ehrlich, '91) against this overdosing, but were unheeded, and finally a storm of indignation arose which reached its climax when Virchow ('91) stated that he found softening and recent extension of disease in patients treated with tuberculin and dying of tuberculosis, and the period of "tuberculin delirium" was over.

It is manifestly unfair to select pathologic changes occurring in a patient dying of tuberculosis either as proof for or against any line of treatment unless these changes are such as rarely, if ever, occur in untreated cases. Virchow later acknowledged that all the changes he had observed do occur in untreated patients dying of tuberculosis. The only accurate pathologic data as to the value of tuberculin would be those obtained from patients treated with tuberculin and dying of an acute intercurrent disease, as Bandelier and Roepke point out.

The age of "tuberculin terror" may be said to have begun at this time, and he who used tuberculin was looked on by many as a criminal. A few men (Trudeau, Goetsch, Klebs, Petruschky, von Ruck) continued the use of tuberculin, and to them is due the fact that the period of "tuberculin renaissance," which began a few years ago, came to pass.

Much chemical work was done on O. T. by many men, who tried to separate a beneficial substance from those capable of injuring the patient. Hunter ('91) carefully analyzed tuberculin, and obtained by precipitation with ammonium sulphate a substance (Modification B) which he thought superior to O. T. Trudeau used the same procedure with the broth filtrate, but neither of these were found of more value than O. T. Klebs, who was one of the first to work along this line, has consistently adhered to his belief that by treating the O. T. with bismuth iodid, and filtering off the precipitate, he was able to obtain the beneficial substance by further precipitation by alcohol (tuberculocidin). This has not been widely used, but some report good results from its oral administration.

Koch early recognized that O. T. produced no perfect immunity to tuberculosis, and he also tried to separate from the tubercle bacilli the beneficial agent which he believed it contained, for the whole tubercle bacillus when injected subcutaneously produced abscesses. By extraction with sodium hydrate he obtained *tuberculin alkalinum* (T. A.), which on account of its abscess-producing qualities he quickly discarded. Having observed that at death many tissues failed to contain tubercle bacilli where they had apparently been present, he sought some means whereby he could make the tubercle bacilli more absorbable, for, he argued, had this but occurred earlier in the animals, immunity might have been acquired. The results were unsatisfactory, and he finally announced a new tuberculin—tuberculin residuum (T. R.) (Koch, '97)—consisting of an emulsion of pulverized, water extracted, virulent tubercle bacilli. The water extract he called *tuberculin obere* (T. O.), and said it contained the fever-producing substances and should not be used. This new tuberculin, he believed, should be used so as to avoid all strong reactions, but the results were not satisfactory.

Finally, in 1901, Koch ('01) recommended for use an emulsion of tubercle bacilli which he said should be given in increasing doses in spite of reactions, first subcutaneously and finally, if necessary, intravenously, having in view the production of a strong agglutinating power in the serum. This was the beginning of the "tuberculin renaissance," and since this time many tuberculins have been widely used.

The work of Goetsch, published in 1901 with a postscript by Koch, paved the way in Germany for a wide use of tuberculin, while in America Trudeau's ('07) work has had the same influence.

Denys's work ('07) called attention to the filtered bouillon culture of tubercle bacilli (B. F.) and emphasized emphatically the great care necessary in the use of any tuberculin. Trudeau's recent papers have also laid great stress on this point. Like strychnin, arsenic, and many other drugs, tuberculin may be of value when given properly, and is certainly a most potent poison when injudiciously given.

From his oracular communications von Behring would lead us to suppose that he had solved the problem of making at one and the same time the tubercle bacilli both absorbable and unable to produce tuberculosis when injected into man or animal. Proof of this is still lacking.

Vaughan (and Wheeler, '07) has, with his split products of the tubercle bacillus, endeavored to separate the poisonous from the beneficial part, and he uses the latter for immunization. It acts, he believes, by promoting bacteriolysis.

More recently still Deycke and Reschad Bey ('07) have obtained from a streptothrix found in lesions of leprosy a waxy substance which they have named nastin. Apparently it has a bacteriolytic action on the tubercle bacillus when injected subcutaneously, and can only be used, they believe, in very early stages, on account of the toxemia that would otherwise occur.

Livierato, Klebs, and Maragliano all claim to have obtained some bacteriolytic action.

The work of Moeller, Loewenstein, and Rappoport from Belzig, of Turban, Schnoeller, and Frey of Davos, of Wright of England, of Maragliano of Italy, of von Behring of Marburg, and of many others too numerous to mention, has done much to throw light on this most suggestive and intricate subject.

SCHEMA FOR TUBERCULINS AND TUBERCLE BACILLUS VACCINES

The following schema of tuberculins and tubercle bacillus vaccines is arranged in three large groups, according as use is made of the culture fluid, the tubercle bacillus or both culture fluid and tubercle bacillus. The culture fluid of the first group consists of Koch's original formula, and the various preparations are grouped according to the strain of tubercle bacilli and the amount of heat employed. The preparations of the tubercle bacillus are discussed in a similar manner, but are grouped under four heads—dead bacilli, living bacilli, extracts of bacilli, and decomposition products. In the third large group of "Culture Fluid and Extract of Tubercle Bacilli," other formulas of bouillon have been used, which is taken into consideration as well as the strain of tubercle bacillus and the degree of heat.

I. FILTRATE OF CULTURE (KOCH'S FORMULA)

Filtration through paper or candles (Berkefeld, Chamberland, etc.).

A. Human Types

a. Unheated

1. Unchanged B. F. (Koch, Denys, Trudeau).
2. Precipitated $(NH_4)_2SO_4$ Mod. B. (Trudeau).
3. Filtered and evaporated to one tenth in vacuum (or thermostat at 37° C.) TOA (Spengler's toxoid.

b. Heated

to 60° C. or less

1. To 30° on water bath after filtration through porcelain (Maragliano).
2. Filtration, then concentration to one tenth at 57° (Arloing and Guinard).

b. Heated

to 100° C.

1. Fractional distillation under N. (bacillosine, Vaillant).
2. Sterilized, filtered, diluted with H_2O and glycerin, 10 gms. toxine, Lannoise.

B. Bovine Types

Unheated and heated (theoretical).

C. Avian Types

1. *Unheated:* Unchanged—A. "B. F." (theoretical) Courmont and Dar. experimental.

2. *Heated* (theoretical).

D. Piscine types (theoretical)

E. Other "cold-blooded" types (theoretical)

F. Acid-fast types (theoretical)

II. BACILLARY BODIES

A. Human types (dead)

a. Untreated

1. Allowed to die (Jousset).

b. Treated

1. By grinding without heat, centrifuged and glycerin-treated:
   T. R. (some extraction with water).
   B. E. (bacillary emulsion).
2. By heating to 60° C. (Wright).
3. Extraction with ether. Fat-free bacilli (treated with iodin and KI given internally (Cantacuzene)).

B. Other strains (dead)

C. Human types (living)

a. Unchanged

Bovo-vaccine (v. Behring).
Tauruman (Koch-Schütz).

b. Attenuated by

1. Decomposition.
2. Heat.
3. Prolonged growth.
4. Chemical means (unsuitable media).
5. Glycerin (Levy).
6. Passing through refractory animals—blindworm (Moeller), turtle (Friedmann).

D. Avian types (living)

Hericourt and Richet, McFadyean.

E. Bovine types (living)

Spengler, Klemperer (in man).

F. Cold-blooded types (living)

Blindworm (Moeller), turtle (Friedmann), frog (Knester).

EXTRACTIONS OF BACILLARY BODIES

(Only human types used)

a. Unheated

1. By alkalies T. A. (Koch).
2. By water T. O. (Koch).
   Watery extract (von Ruck).
3. By pressure: tuberculo-plasmin (Buchner and Hahn).
4. By chloral hydrate, etc.
   Tuberkulose, Tulase, Tulaselaktin } (v. Behring).
5. By chloroform and ether (Auclair).
6. By oil (Siallero).
7. By pure H_2SO_4, etc (Tuberkulotoroidin, Ishigami).

b. Heated

1. Water and concentrated (100° C.) (Maragliano).
2. Glycerin and water (150° C.). T. D. R. (v. Behring).
3. Fractional distillation at different temperatures.
   Tuberculol (Landmann).

DECOMPOSITION PRODUCTS OF BACILLARY BODIES

1. Tuberculinic (nucleic) acid (Ruppel, Levene).
2. Tuberculosin (Ruppel).
3. Tuberculosamin (Ruppel).
4. Nucleoproteid (3, Levene).
5. Split products (Vaughan).
6. Alkaloid of tubercle bacilli, crystalline toxin treated with Ca permanganate—tuberculinum (Baudron). (Not from T. B. Nastin (Deycke-Reschad Bey).

III. CULTURE FLUID PLUS BACILLARY BODIES

A. Bouillon—Koch's Formula

I. Human

a. *Unheated* (theoretical).

b. *Heated* to 100° C.

a^1. Old (original tuberculin (tubercle bacilli water bath at 100° C.) boiled in bouillon and evaporated to ten per cent original volume—Koch).

1. *Precipitated* by:

a^2. Alcohol (sixty per cent)—purified (Koch).

b^2. $(NH_4)_2SO_4$, Hunter's Mod. B.

c^2. By alcohol, chloroform, benzol, tuberculinum deparatum (Klebs) (discarded).

d^2. Sodium-bismuth-iodid in acetic acid and then by alcohol. Antiphthisin (Klebs) discarded.

e^2. Alcohol and sodium-bismuth-iodid. Tuberculocidin (T. C., Klebs).

2. *Extracted* with NaOH (Weyl).

3. *Oxidized* by H_2O_2—oxytuberculin (Hirschfelder).

b^1. Tubercle bacilli of standard virulence used, bouillon evaporated to eight per cent, filtered and sterilized. Jacobs ('04) tuberculin (T. J.).

c^1. Heated to 60° C. or less (theoretical).

II. Bovine

a. Unheated—theoretical.

b. Heated—P. T. O. (Perlsucht tuberculin) (Spengler).

III. Avian

a. Unheated—theoretical.

b. Heated and evaporated (avian "old tuberculin") (Roux).

IV. Piscine

a. Unheated—theoretical.

b. Heated and evaporated (piscine old tuberculin) (Terre, Ramont and Ravaut, Bataillon, Moeller and Terre).

V. Other Cold-blooded Tubercle Bacilli

a. Unheated—theoretical.

b. Heated and evaporated. Blindworm tuberculin (Moeller, from Dieudonné).

VI. Acid-fast Bacilli

a. Unheated—theoretical.

b. Heated—timothy hay, grass bacilli (Moeller), paratuberculin irimescu, dung, pseudo-bovine.

B. Other Formulas than Koch's

I. Human

a. Unheated. Tuberculin precipitated by alcohol sixty per cent from glycerinized, nonneutralized, nonpeptonized bouillon, and added to equal parts of precipitated orthophosphoric acid (one per cent) extract of tubercle bacilli of standard virulence, and dissolved in 20 parts of diluent (Béraneck).

b. Heated to 100° C.

1. More glycerin, no meat extract, otherwise as in O. T. (Veseley).
2. Potassium-acid phosphate, ammonium phosphate, asparagin, glycerin, added to bouillon (De Schweinitz and Dorset).
3. More glycerin, neutralized with $NaHCO_3$, not boiled and reduced in vacuum to eight per cent (Ponzio).

II. Bovine, etc.

All theoretical.

VARIETIES OF TUBERCULIN USED CLINICALLY

The varieties of tuberculin that have been most used clinically, together with a brief description of their preparation, include:

1. **Old Tuberculin** (Koch).—A boiled (for one hour), concentrated (on a water bath to one tenth volume), and filtered (through a Chamberlain filter) "beef broth" (containing five per cent glycerin, neutralized) culture, six to eight weeks old, of human tubercle bacilli, irrespective of virulence or of strain, but usually much attenuated. The finished product contains fifty per cent glycerin.

2. **Tuberculin R.** (Koch).—An unheated twenty-per-cent glycerin emulsion of living, virulent, pulverized tubercle bacilli, which have first been extracted with water (water extract named *tuberculin obere*), containing finally in each cubic centimeter 10 mgm. of solid substance.
3. **Bacillen Emulsion, B. E.** (Koch).—An unheated fifty-per-cent glycerin emulsion of living, virulent, pulverized tubercle bacilli containing 5 mgm. of solid substance in each cubic centimeter. The coarser particles are removed by centrifugalization. Arloing believes that B. E. affects breathing more than old tuberculin, the effects of B. E. last longer than O. T., and that the severity depends upon the virulence of the bacilli in the emulsion and in the animal.
4. **Tuberculocidin (T. C.) and Antiphthisin** (Klebs).—The old tuberculin is first precipitated with bismuth (tuberculocidin) or potassium-bismuth-iodid in acetic acid (antiphthisin) and then with alcohol.
5. **"Watery Extract"** (von Ruck).—Tubercle bacilli are washed with water, then first extracted with alcohol and ether and pulverized, and finally extracted with water at 50° C.
6. **Broth Filtrate (B. F.)** (Denys).—The unheated, unconcentrated, filtered (through porcelain) bouillon culture of human tubercle bacilli. Denys believes this is ten to a hundred times as strong as O. T., but Baldwin has proved O. T. far more toxic for guinea pigs.
7. **Béraneck's Tuberculin.**—A twenty-per-cent solution of equal quantities of the unheated precipitate (by sixty per cent alcohol) of a culture of tubercle bacilli of standard virulence on glycerinated, nonneutralized, nonpeptonized bouillon and of an orthophosphoric acid (one per cent) extract of untreated tubercle bacilli. It is less toxic and less vaso-dilating than O. T.

Living tubercle bacilli were found at first in T. R. and B. E. by Thellung, in B. E. by von Meissen, and in T. R. by Huber. Many other contaminating bacteria were present at first in some specimens (Baumgarten and Walz).

Tuberculase, tulase, and tulaselaktin of von Behring are products of or altered tubercle bacilli, whose preparation has never been made known.

No accurate method of standardization of tuberculin has yet been found, though Doenitz, Otto, and von Lingelsheim have all suggested methods, the first two using tuberculous with subcutaneous, the latter healthy guinea pigs with intracerebral injections.

Comparison of the strengths of the various tuberculins were made by von Behring on twenty tuberculous cattle, and he found—

1 part T. R. = 2 parts O. T.

1 part tuberculin purified by partial alcohol precipitation = 4 to 6 parts O. T.

1 part dried and pulverized tubercle bacilli = 4 to 5 parts O. T.

1 part nuclein substance = 3.5 to 4.5 parts O. T.

1 part tuberkulosamin = 3 to 3.5 parts O. T.

1 part tuberculinic acid = 3.5 to 4 parts O. T.

C. Spengler states bovine tuberculin causes a more intense skin and "organ" reaction than O. T.

As Guinard ('02) remarks, there are two principal objects in all the work on tuberculin: (1) To free the tuberculin of its dangerous constituents and to preserve its useful ones; (2) to obtain more of the latter either by changing the media used for growth of the tubercle bacillus or by employing a better method of extraction. On the whole, the results do not permit us to think that a single tuberculous extract bearing the name of tuberculin is able to be taken as a type or represents a fixed product, constant in its composition and in its effects. All probably contain the specific nucleic acid. What Maragliano said in 1898 is still true to-day: "There is no tuberculous poison entitled to the name because it has not been isolated in a state of purity. They have always been in glycerin or aqueous solutions under different forms of precipitates, dried or redissolved, more or less mixed with other albumoses." Guinard also agrees with Arloing, who claims that however slightly the microbic products are treated, the active element may be changed.

CHEMISTRY OF TUBERCULIN

Old tuberculin, Kuehne found, differed only quantitatively from the broth-culture fluid. It gave all the proteid reactions, but resisted heat (160° C. for two hours in 50 per cent glycerin solution), so differing from all known albumoses and toxalbumins. The largest amount of active substance was precipitated by 60 per cent alcohol, and the crude and precipitated tuberculin contained on an average 18.86 per cent ash, chiefly K and Mg phosphate. Kuehne found in tuberculin by analysis no alkaloids, but (1) an albuminate (nucleoproteid), (2) a peculiar (acro-) albumose, (3) deutero-albumose, (4) traces of peptone, and (5) tryptaphane, a digestive product.

Ruppel, who examined broth filtrates heated only to 30° to 40° C., found no specific substance differing in chemical reactions from the proteids in the original broth.

The nucleoproteids and tuberculinic acid obtained by extracting bacilli with water, with glycerinated water (three to five per cent), or with weak alkaline solutions contained *much* of the active principle. This substance is probably in proteid combination, and while peptic digestion weakens its activity, tryptic digestion destroys it (Baldwin and Levene) and it is not easily dialyzable. Tuberculin obtained from the bovine bacilli is strongest, that from the human weaker, while that from the avian is weaker still (Ruppel), a fact that Smith explains by the increased alkalinity of the bovine cultures.

It has long been held that if only a more virulent toxin could be obtained from the tubercle bacillus, or from its culture fluid, immunization might be possible. Much work by Ruppel, Levene, and others has resulted, but no advance has been made along this line for some time, and it is now, for the present, at least, abandoned (Ott, '03).

METHODS OF ADMINISTRATION

Intravenous.—While Koch at first advised tuberculin to be administered hypodermically, in 1901, when he announced his B. E. and intimated that it was necessary to obtain a high agglutinating power in the blood to an emulsion of pulverized tubercle bacilli, he suggested that as large doses of B. E. caused, when given subcutaneously, abscesses, that these doses be given intravenously. Few, however, now accept the importance Koch at that time attributed to agglutination as the index of immunity and intravenous injection of tuberculin may be said to be almost never used. Rothschild, M. ('06), and Heermann ('05) have reported good results in some patients with this method, and Denys has used it. The dose is one tenth the amount given subcutaneously, and the fact that the best immunity has been obtained with living bacilli by this method should arrest attention.

Oral.—Tuberculin has been administered in nearly every conceivable way. Freymuth ('05) has given it per os in the form of kaolin-coated pills, after neutralization of the gastric juice with sodium bicarbonate to avoid digestion in the stomach, while Klebs takes no account of this factor. Huhs ('07), who reacted severely to small doses subcutaneously (100° F. after 0.00005 O. T.), took 1 gm. O. T. by mouth with and without neutralizing the gastric juice with a large amount of sodium bicarbonate, and yet, although he had taken 20.000 times the foregoing minimum dose, it had no effect whatsoever. Recent work on serums has shown that antibodies in serums are absorbed unchanged from the alimentary tract only during the first two weeks of life or when the epithelium is injured, but Calmette and Guerin ('07) have succeeded in vaccinating calves by feeding them tuberculous

milk, while Figari and Maragliano claim to have had excellent results in guinea pigs from oral administration of blood clots from immunized calves and horses. The work of Levene, Baldwin, and Kinghorn shows that tuberculin is affected by the digestive processes in the stomach and intestines. Furthermore, it is impossible to gauge accurately the dose by this method (Loewenstein and Koehler) or by inhalation, and consequently severe reactions may occur when least expected and hypersensibility result.

Inhalation.—Kapralik ('04) and von Schroetter ('04) have employed tuberculin by inhalation in the form of a spray, first suggested by Moeller, a method requiring large doses and incurring, therefore, much expense. Bandelier obtained no results from inhalations, and Huhs thinks them of little value.

Jacobs injected tuberculin intratracheally, to enable a large quantity to reach the site of the lesion, and was severely criticised by his confrères. Tuberculin in solution is well absorbed from the lungs, but the dosage is inexact, and what can be hoped from saturating with tuberculin an organ which already contains much of it is difficult to see.

Dermic.—Administration by rubbing into the skin is only of value in hypersensitive individuals and children. It has marked limitations which Spengler ('03) has noted, and further may be accompanied by disagreeable skin reactions. Spengler rubs into the forearm of patients who are hypersensitive 1, 5, and 10 mgm. at intervals of two to four days. In two weeks the subcutaneous injections can be recommenced. Proper dilutions render this method entirely unnecessary.

The rectal and the intrapulmonary injection (Livierato) of tuberculin need only to be mentioned to be condemned.

Subcutaneously.—Tuberculin injected subcutaneously is nearly at once absorbed by the lymphatics. It is of interest to bear in mind that the large mononuclear cells which seem chiefly concerned in the process of immunization in tuberculosis are probably derived from the endothelial cells of the lymph and blood-vessels, which are directly stimulated by this method, and stimulated most intensely at a point far distant from the area of infection. Béraneck, however, opposes this view, and believes tuberculin should be injected directly into or immediately about the focus. A careful consideration of all these methods unquestionably leads to the conclusion that the subcutaneous method is by far the most exact, the most reliable, the most elastic (adaptable), and the most efficacious. The same arguments apply here that are used in favor of the hypodermic administration of drugs. For these reasons the discussion here is limited entirely to the subcutaneous administration of tuberculin.

DILUTIONS

Tuberculin in many instances produces at the site of injection the four classical signs of inflammation—*tumor, robor, calor,* and *dolor.* It is natural to presuppose that the tissues are less resistant to infection at this point, but care in regard to asepsis always prevents suppuration unless large doses of B. E. have been given, when, in spite of asepsis, local sterile abscesses may occur. All emulsions or vaccines of tubercle bacilli should always, therefore, be well diluted, but this is not necessary with many other forms of tuberculin.

Preservation in Dilution.—In all cases, except where large doses of tuberculin are used, it is necessary to dilute the original tuberculin, as at present few tuberculins are put on the market in a form sufficiently diluted for the earlier doses. Furthermore, it has not yet been determined how long the high dilutions retain their strength, especially when a small percentage of some antiseptic has been added. High dilutions apparently retain their strength for two weeks, and it is not improbable that they may do so for a much longer period, but until sufficient proof of this is adduced they should be made up fresh every two weeks. Jacquerod says a ten-per-cent solution degenerates only after six weeks.

It is best to keep the tuberculin as well as all dilutions in a cool place (ice box) protected from light. In making the dilutions the greatest care should be used not to contaminate the original tuberculin, which should be in a paraffined, rubber-stoppered, dark bottle. If contaminations do occur—i. e., if the original tuberculin becomes more cloudy (some forms are never clear)—it should be discarded and not used. With care this is practically never necessary, and no instance of any sort has ever suggested to the writer that the tuberculin he was using should be resterilized.

Method of Diluting.—The dilution of tuberculin is a comparatively simple process that demands little previous experience but great exactness. If at any time during the process of dilution a question of error arises, it is well to throw aside the dilutions and start anew.

The instruments necessary for making dilutions are a 1-c.c. glass pipette, graduated into hundredths of a cubic centimeter, with a scale at least 15 cm. long and a long, conical 10-c.c. graduate. These should always be boiled before use, though some recommend keeping them in a disinfecting solution (alcohol, etc.) and rinsing with a diluent before using. A glass syringe with a capacity of 1 c.c., with a long, narrow barrel, graduated into hundredths of a cubic centimeter, is much easier to use, and, if accurately graduated, is more exact. It matters little, however, whether either the pipette or syringe be accurately graduated, provided that the same instrument be used each time. This syringe

is also the best for use in giving tuberculin. The actual dose is of far less importance than the relative dose. If a syringe be used, it should

Fig. 147.—Instrumentarium for Tuberculin Injections. From left to right: Sterilizer, large (1,000 c.c.) and small (100 c.c.), measuring cylinders, flask with sterile water, bowl, three small bottles holding tuberculin stock solutions (B. E. and B. F.). On shallow glass dish with hypodermic syringe, holding 1 c.c., subdivided into 100ths c.c. In front calibrated pipette.

be freed carefully from water and rinsed several times in the solution to be diluted (see Fig. 147).

Diluents.—The best diluent is probably one fourth per cent phenol in physiologic saline solution. It should be carefully boiled and filtered from time to time. Phenol may be replaced by lysol in the same strength. For emulsions of the tubercle bacillus, which should always be shaken before using, Koch recommended that the diluent should be physiologic salt solution, but the ordinary diluent may be used.

Estimating Dilutions.—When a table for dilutions is not at hand, the easiest method is to decide what content per cubic centimeter is desired. For example, if 10 c.c. of a diluent, in which 1 c.c. = 0.000001 c.c. of the original tuberculin, be required, with a pipette or syringe 0.1 c.c. of the original tuberculin is taken and the diluent added until 10 c.c. is reached. Then as 0.1 c.c. is in 10 c.c., 1 c.c. must contain 0.01 c.c. Repeating this, a solution is obtained of which 1 c.c. = .0001 c.c. of the original tuberculin. The amount desired of the final solution determines how much of this solution should be used. As it is wished

to get 10 c.c. of a solution in which 1 c.c. = .000001, multiply .000001 by 10, obtaining .00001. This amount of tuberculin is contained in 0.1 c.c. of the last solution, which is measured out and diluted up to 10 c.c., which gives the required strength—i. e., 1 c.c. = .000001 of the original tuberculin. This process may be continued until any required dilution be obtained. By adding diluent until a volume of 100 c.c. is reached, fewer intervening dilutions are necessary. It is unwise to attempt to measure less than 1 c.c. when making dilutions. The accompanying schema, in which grams are equivalent to cubic centimeters, has long been used at the Adirondack Cottage Sanitarium, and has given much satisfaction:

Variety of tuberculin..... Strength of original.....		O. T. or B. F. 1 g. to 1 c.c.	T. R. .01 g. to 1 c.c.	B. E. .005 g. to 1 c.c.
Solution No.	To make 10 c.c. of solutions of following strengths—	Take	Take	Take
0	1 g. to 1 c.c.	10 c.c. Tuberculin.	——	——
I	.1 g. to 1 c.c.	1 c.c. Tuberculin. 9 c.c. Diluent.	——	——
II	.01 g. to 1 c.c.	0.1 c.c. Tuberculin 9.9 c.c. Diluent. or 1 c.c. Solution I. 9 c.c. Diluent.	10 c.c Tuberculin.	——
III	.001 g. to 1 c.c.	0.1 c.c. Solution I. 9.9 c.c. Diluent. or 1 c.c. Solution II. 9 c.c. Diluent.	1 c.c. Tuberculin. 9 c.c. Diluent.	2 c.c. Tuberculin. 8 c.c. Diluent.
IV	.0001 g. to 1 c.c.	0.1 c.c. Solution II 9.9. c.c. Diluent. or 1 c.c. Solution III. 9 c.c. Diluent.	0.1 c.c. Tuberculin 9.9 c.c. Diluent. or 1 c.c. Solution III. 9 c.c. Diluent.	0.2 c.c. Tuberculin. 9.8 c.c. Diluent. or 1 c.c. Solution III. 9 c.c. Diluent.
V	.00001 g. to 1 c.c.	0.1 c.c.Solution III 9.9 c.c. Diluent. or 1 c.c. Solution IV. 9 c.c. Diluent.	0.1 c.c.Solution III 9.9 c.c. Diluent. or 1 c.c. Solution IV. 9 c.c. Diluent.	0.1 c.c. Solution III 9.9 c.c. Diluent. or 1 c.c. Solution IV. 9 c.c. Diluent.
VI	.000001 g. to 1 c.c.	0.1 c.c. Solution IV 9.9 c.c. Diluent. or 1 c.c. Solution V. 9 c.c. Diluent.	——	0.1 c.c. Solution IV 9.9 c.c. Diluent. or 1 c.c. Solution V. 9 c.c. Diluent.

PREPARATION FOR INJECTIONS

Cleansing of Skin.—The area of skin selected should be vigorously rubbed with alcohol both before and after the injection. No other cleansing is necessary, and the use of antiseptics, ether, cotton, collodion, etc., is superfluous. In thousands of injections made by the writer, alcohol alone has been used and no infection has ever occurred.

Needles.—The needles used should be very fine, should be rinsed in alcohol or ether after using and in boiling water before using. They need not be boiled, nor need they be kept in alcohol if they are not used for any other purpose. The platinum-iridium needles used by some (Holdheim) are unnecessary.

Accidental Inoculation.—When tuberculin is given to a large number of patients, great care should be taken to avoid ejecting a spray of tuberculin into the air when forcing out bubbles of air, as reactions have been produced in this way. The boiling water used for rinsing the syringes between injections should always be fresh, and graduates or pipettes used for making dilutions should never be placed in this water, nor should the water drawn up into the syringe be ejected back into this pan. The physician, if tuberculous, should always wash his hands after handling tuberculin.

Site of Injection.—During the rubbing for cleansing, the site should be examined to see that it is free from indurations left from previous injections. The occurrence of these indurations vary both for individuals and for the form of tuberculin used.

The usual site is 4 to 8 cm. from the midline opposite the seventh to the tenth dorsal spines. The skin is usually thick, less vascular, easily movable, and less sensitive in this area. It should be given well under and not in the skin.

Béraneck believes that his tuberculin acts more favorably when injected near or directly into the focus in surgical tuberculosis, as it produces an increased phagocytosis and possibly sets free bacteriolytic ferments from the cells. He has not advocated intrapulmonary injections. Crocker and Pernet advise local injection in lupus.

The toxin enters, often continuously, into the circulation about the tuberculous foci, and the contiguous cells are constantly stimulated. In tuberculin treatment it is injected at intervals into the lymphatics (subcutaneous), far removed from the disease foci. The latter process may call into play the whole body, especially the lymphatic system, while the action of the former may be limited to the circulatory system, possibly of a limited area.

DOSAGE AND INTERVAL

General.—The crucial point in the tuberculin treatment is the selection of the dose and interval. The literature of the period of tuberculin delirium (1890–91) is filled with reports of patients who were excessively overdosed, and in some instances undoubtedly killed by overdosing with tuberculin. The few men who continued to use tuberculin were those who from the first employed much smaller doses than were in current use. To Guttmann and Ehrlich, to Goetsch particularly, to Denys, to Trudeau, and to Wright do we owe the present recognition of the value of small doses. Two men, however, Denys and Wright, deserve special mention in this connection. Denys in his book, "Le Bouillon Filtré," has given the best exposition of the clinical value of beginning with small doses of tuberculin in all forms of tuberculosis, and Wright, basing his opinion on his studies of the opsonic index, has emphasized the great benefit to be derived from small, repeated, or very slightly increased doses of tuberculin in surgical tuberculosis. The method of administration of tuberculin is far more important than the variety of tuberculin, and he who fails to consider that tuberculin is a most potent poison, is a dangerous man. Too great care cannot be exercised, and carelessness may be equivalent to homicide. A beginner who presumes on his inexperience is likely to have woeful results.

Beginning Dose.—The first dose of tuberculin should be so selected that all possibility of reaction is excluded. Koch, C. Spengler, Bandelier and Roepke, and others have advocated that slight reactions (under 100.4° F.) are necessary for the best results, while the vast majority of observers endeavor to avoid reactions whenever possible, but, in spite of all precautions, slight reactions will occasionally occur during the course of the treatment. In all patients who have recently been subjected to the tuberculin test, in all who have a subfebrile temperature, extensive pulmonary involvement, a nervous temperament, or complications, more care about the dosage should be exercised at first. One patient, a well-nourished, strongly built woman aged twenty-four years, with extensive infiltration and slight apical consolidation of the left lung, reacted to 0.0000001 c.c. of broth filtrate (B. F.), and for four months was unable again to reach so large a dose. Another patient, a strongly built male, aged forty, with extensive signs of infiltration in both lungs, was given without reaction a first dose of 0.000005 c.c. B. F., and in six weeks with biweekly doses reached 0.001 c.c. The susceptibility to tuberculin varies greatly both in different patients as well as in the same individual at different times, and cannot be estimated accurately beforehand either from the physical signs, the symptoms, or, indeed, from any data at our command. Such facts

emphasize the great necessity for careful individual treatment of each patient, and beginners especially should studiously avoid producing any evidence of reaction.

The size of the first dose has been directly affected by the idea that the tuberculin treatment should extend over many months, and the final dose still influences many men in the selection of the first dose. This is especially true in sanatoriums, where oftentimes both patient and physician feel as if they must begin with as large a dose as possible and hurry on until a large final dose, often 1 c.c., is reached. (See Duration of Treatment.) This is based on wrong premises, as all patients need not be carried to the same dose to derive equal benefit, and the final dose should have no influence on the first. It is often well, as Sahli also holds, to repeat the first dose, especially if there be any doubt about its causing a reaction. The initial subcutaneous dose for the tuberculins most frequently used are given on pages 540–541.

Interval.—When first used, tuberculin was given every day, a method soon found to be wrong. Many to-day, however, advise that at first it be given every day or every other day, and later every three or four days. As even slight reactions may not be manifested until as late as forty-eight or even sixty hours, the danger of giving tuberculin oftener than every three or four days (biweekly) is apparent. Many patients, especially those susceptible, often do better by taking but one dose in seven to ten days. This more nearly corresponds to the time required for the formation of antibodies, and fits in with the clinical work of Wright and others. When large doses (0.5 c.c. B. F. or O. T., or 2 mgm. B. E.) are reached, an interval of seven to fourteen days is none too long. Furthermore, when tuberculin is given at too short intervals, hypersensibility may occur.

Increase of Dose.—The first dose, if sufficiently small, requires little consideration, but the key to successful tuberculin treatment lies in a proper gradation of the doses. It is here that experience is necessary and judgment at times difficult, for it is now well recognized that objective reactions are not necessary and should be avoided. The formation of antibodies requires time, and a quick increase is, therefore, of little avail, while some hold that increase beyond a very small dose is of no value (Wright), but to get tuberculin immunity, a steady increase without reaction must be maintained. The most important rule to be remembered is that too little never injures, while too much tuberculin may provoke a serious reaction and hypersensibility (see p. 538). Whenever, therefore, a question about a larger or smaller dose arises, it is well to choose the latter, for when hypersensibility is once provoked, it may be impossible to produce tuberculin immunity, and

at least for some months the treatment may have to be discontinued (p. 549). In mild instances it may be sufficient to omit several doses, to reduce markedly the next dose and to lengthen the interval.

The results of any single dose of tuberculin, well within the limits of reaction, have been most difficult to estimate. The administration of tuberculin has been, and, in the hands of most observers, still is undoubtedly empirical in the sense that they have at hand no practical means, either clinical or laboratory, of estimating exactly what the next dose should be from the effects produced by the last.

Laboratory Method.—The indications for increasing the dose may be based on clinical or laboratory observations or on both together. The only laboratory method of any value is that devised by A. E. Wright ('04) and based on the opsonic index. The long apprenticeship necessary to acquire the technic, the time-consuming details, and the many chances for error inherent in the determination of the "opsonic index," make Wright's method of little practical value where tuberculin is given to a large number of patients, while in regard to pulmonary tuberculosis he states that it is of no value, except in the very earliest stages. Recent work at Cambridge (England) would seem to show that to avoid error it is necessary to count 1,000 cells, and inasmuch as it is necessary to compute the index every other day for four or five times following a dose of tuberculin to study its effect, the magnitude of the work is appalling. Wright has, however, emphasized the value of small repeated doses of tuberculin, especially in surgical tuberculosis. He strives to increase the tuberculo-opsonic content of the blood and totally discards all idea of a tuberculin immunity, though some is probably acquired (p. 525). Wright's opsonic index method, while not practical, is a great step in the right direction, inasmuch as it attempts to estimate the results of each dose of tuberculin. (For technic, see Appendix.)

Clinical Method.—Careful clinical observations afford sufficient data for the proper administration of tuberculin when tuberculin immunity is the object. Such methods are, however, gross, and all have to acknowledge that, in spite of the most careful observations, occasional reactions will occur. Many have attempted, by studying the various fluids and excreta of the body, to determine the proper dosage. The urine has afforded no help and the sputum has been studied in regard to the number of tubercle bacilli, their virulence, morphology, and the number found intracellular (phagocytosis), but none of this is of avail in regard to the amount of the next dose. The blood has yielded no help either from a study of the erythrocytes, of the leucocytes (total or differential count, Arneth's ('05) neutrophilic picture, except after

a reaction [1]), or from a study of the serum in regard to agglutinization. The opsonic index has been discussed, and in pulmonary tuberculosis, where tuberculin immunity is the object, it can, as Kinghorn and Twitchell have shown, be ignored. The index fluctuates, and whether tuberculin be given at any stage of a negative or positive phase, is as likely to go up as down. The blood-pressure aids little (Bauer, Miller). In fact, after careful consideration of the whole question, we are forced to rely chiefly, if not entirely, on the symptoms, general and localizing, the temperature, pulse, weight, and strength, and the phenomena that occur at the site of injection.

Time of Injection.—In order to observe best these symptoms, it is wise to give the injections in the evening or afternoon, and not in the morning as some advise (Sahli, '06; Bandelier and Roepke, '08). Another advantage of giving the injections late in the day is the opportunity afforded for observing on the day of injection the maximum temperature, which in a number of instances precludes the dose. Sahli's contention that the normal morning remission may obscure a slight rise when tuberculin is given in the afternoon or evening is probably based on the fact that he usually administers it during the morning, but Béraneck's tuberculin may cause a quicker rise of temperature. Whether the minimal or maximal temperature is affected first would decide this point, as the reaction usually begins about ten or twelve hours after the dose. When given late in the day, the afternoon or evening temperature on the following day is much more frequently and more violently affected than the morning temperature.

Record of Treatment.—The observation of these symptoms has to be, in many cases, at least, relegated to the patient, and he should be made aware of what symptoms to note, as, like most men, even when trained, he will observe only what he looks for. He should be supplied with a reliable thermometer, taught how to take his oral temperature, and required to take it at least three times a day, on awaking, at 4 and at 8 P.M., and at any other times of the day he may feel that he has some elevation of temperature, or at the time of the individual daily maximum, for one week previously as well as throughout the treatment. When restless at night after tuberculin he should also take his temperature. These should all be noted in a booklet, together with the presence or absence of the symptoms mentioned below, where are reproduced specimen pages of a booklet used by the writer with considerable satisfaction for some time.

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[1] Arneth holds that his blood picture is of some value in estimating the dose, but this lacks confirmation.

This little record book is intended to aid your physician to give you tuberculin more carefully, more intelligently, and more scientifically. He must depend upon your accuracy, which, accordingly, is closely connected with the benefits you will derive from this line of treatment. Put down no statement that is not, according to the best of your knowledge and belief, true in every particular and not in any way misleading.

To render the temperature records accurate, it is never wise to leave the thermometer in your mouth less than five minutes, and in cold weather or out of doors the mouth should be kept closed for fifteen minutes, the thermometer then inserted and left in place for ten to fifteen minutes.

If you are taking the tuberculin treatment, the list of symptoms should be carefully scanned. The signs "+" and "0" may be used to indicate "present" and "absent." If your back or arm, wherever you receive the injection, does not attract your attention, put down "0" opposite "At Site of Injection." Otherwise indicate what symptoms you have at this spot. If you feel as usual and have none of the "General Symptoms," indicate this by an "0" opposite "General Symptoms." Otherwise put "+" opposite each symptom that occurs and "0" opposite the remainder. The same should be done with the "Localizing Symptoms." When cough, expectoration, or strength are said to be increased or decreased, it means in comparison with the usual amount. The weight should be recorded once a week, and the pulse noted only when it varies from the usual rapidity. The temperature should be taken in the morning in bed before rising and before the teeth have been cleaned. If by experience the highest or lowest temperatures occur at other times than those indicated (7 A.M., 4 P.M., and 8 P.M.), these hours should be changed to the hours at which the minimum and maximum occur. "Low" and "high" are often simple repetitions of these temperatures, but they are useful to your physician. When your temperature reaches 100° F. and remains at this point two hours you should go to bed, unless otherwise directed by your physician. Always go to bed if you feel bad or have any pronounced symptoms. "In bed" means whether you spent the day, morning, or afternoon in bed. "Exercise" means how long each day you exercise, which is usually indicated by the amount taken morning and afternoon, e. g., "½ hour" would mean one half hour's exercise morning and afternoon. Exercise should be greatly restricted the day of the injection, and none taken the following day until late in the afternoon, when, if no symptoms have arisen, a less amount than usual may be taken.

Be perfectly frank and honest with your physician. Tell him of any act of overexertion, and if any symptoms ever occur which are not mentioned in this book, be sure to call his attention to them. It is only by mutual confidence that the best results can be obtained. You are both partners in the most serious business of your life, and partners should discuss every detail of their affairs, which, however, should not be divulged to the rest of the world.

Date							
Dose							
AT SITE OF INJECTION:							
Pain							
Lean against or lie on it							
Swelling							
GENERAL SYMPTOMS:							
Headache							
Pain in limbs							
Pain in joints							
Malaise							
Faintness							
Giddiness							
Insomnia							
Sleepiness							
Fatigue							
Restlessness							
Nervousness							
Stimulation							
Indigestion							
Nausea							
Vomiting							
Chilliness							
Fever blisters							
Rash							
Enlarged glands							
LOCALIZING SYMPTOMS:							
Oppression in chest							
Cough: Increased							
" Decreased							
" As usual							
Expectoration: Increased							
" Decreased							
" As usual							
Pleurisy							
Shortness of breath							
Temperature: 7 A.M.							
" 4 P.M.							
" 8 P.M.							
" Low							
" High							
Pulse							
Weight							
Strength: Increased							
" Decreased							
" As usual							
Appetite							
In bed							
Exercise							

Typical Reaction.—In a typical tuberculin reaction, usually ten to eighteen hours after the injection the patient begins to feel feverish (possibly chilly at first), heavy, and dull, experiences lassitude and has slight elevation of temperature, often detected in the urine stream or rectum before in the mouth. These symptoms are rapidly aggravated, and in a short time the patient feels so ill that he is forced to go to

bed with pains in the back, legs, and head, which are often severe. The tendency to cough may be increased, oppression may be felt in the chest, and the expectoration may be increased. The temperature may rise to 103° F. or higher, the pulse-rate reach 120 or over, the urine may be increased, with a slight trace of albumen or a diazo-reaction, and, on the whole, the patient is ill. These symptoms persist for eight to twelve hours, and usually on the following day the patient feels a little weak, but otherwise all right. In a few instances the reaction is delayed for forty to forty-eight hours, and in others the rise of temperature is less (100° F.), but persists for several days, while the symptoms may be very severe.

Skin Reaction.—The classical signs of inflammation occur at the point of injection, persist for one or two days, but, except with B. E., never go on to suppuration if asepsis has been preserved. Sites of former injections frequently present the same signs, though less pronounced, and the conjunctiva, if the ophthalmic tuberculin test has been given, as well as perceptible tuberculous foci, all show signs of more or less marked hyperemia. The recent work of von Pirquet ('07), Wolff-Eisner ('08), Calmette ('07), and others on the reactions occurring in the skin and in the eye, following the application of tuberculin to these parts, suggests that this local reaction is definitely connected with the tuberculin and not due, especially when great dilutions are used, to any local irritation either of the tuberculin, of the glycerin, or of other constituents or diluents. In many instances when this local reaction is disregarded and the usual rate of increase followed, the skin reaction becomes more pronounced and finally is accompanied by a general reaction.

The relative irritability of the skin of different areas has not been definitely worked out, nor as yet is this reaction satisfactorily explained, though many attribute it to increased susceptibility (*allergie*, anaphylaxis). It is much less pronounced when the injection is made in the back than when given in the limbs. If of great assistance in forestalling a general reaction, it would seem advisable to give the tuberculin in the forearm, an area of skin of great sensitiveness, a procedure which Spengler has long followed. Injection of tuberculin in the skin causes very painful local redness and swelling, and at times minute quantities of tuberculin may accidentally be deposited in the skin on withdrawal of the needle.

These "skin" reactions occur in different individuals with different intensity and vary at different times in the same individual. They occur more frequently at first in some patients, and in others are never present or only with large concentrated doses. They are directly connected with the form of tuberculin used, B. E. causing the reaction most frequently even in great dilution (0.00001 mgm.). In this connection

it is of interest to note that patients who have received the ophthalmo-tuberculin test and either reacted or failed to react (solution used 1:200), in some instances react again more severely or for the first time after the subcutaneous injection of tuberculin. This may occur after tuberculin is used in therapeutic doses and is one of the objections to the ophthalmo-tuberculin test.

Tuberculin should always be administered in the same region of the body but on alternate sides. The concentration of the dose, on the whole, seems to have some influence on the "skin" reaction, and a few patients do react in this way to large doses of concentrated tuberculin, particularly B. E., but the majority take 1 c.c. undiluted of O. T. or B. F. with very slight reaction. The injection of tuberculin into an area of induration produced by a former injection is much more likely to cause this reaction, and in the case of B. E. may produce sterile abscesses. Whenever this "skin" reaction occurs it is well to repeat the dose or to advance very cautiously, for in some cases it is undoubtedly the forerunner of a general reaction. A very severe "skin" reaction would indicate omission of one or two doses and the use of smaller doses for a time.

Organ Reactions.—The occurrence of local or "organ" reactions, manifested by hyperemia, are of great value when they so occur that they can be observed readily (e. g., in lupus, laryngitis, etc.), but it is fallacious to base any method of dosage on the "organ reaction" occurring in the lungs, for it cannot be detected by our methods of exploration in at least sixty per cent of all tuberculin reactions where severe general reactions occur, and, further, the occurrence of physical signs in the lungs is notoriously uncertain even when tuberculin is not administered. Petruschky holds these organ reactions of importance for cure, and Phillipi lays considerable stress on the increase and decrease of catarrhal signs. The writer has not used von Ruck's watery extract where such reactions are said to occur so frequently as to be of value in dosing. Von Eberts has noted a bleaching in an old lupus scar when the correct dose (laboratory method) was given.

Localizing Symptoms.—The localizing or "organ" symptoms may be absent even when rather acute general symptoms are present, and rarely occur with carefully adjusted doses. In pulmonary tuberculosis these consist of oppression in the chest, increased cough, increased expectoration, pleurisy, and shortness of breath. In vesical tuberculosis increased frequency of micturition, in laryngeal tuberculosis, lupus and tuberculosis of the eye, increased congestion of the part are the main manifestations of this "organ" reaction, and are often of the greatest aid in determining the dosage, as in the eye and bladder, particularly, the "organ" reaction is very sensitive.

The exact bearing of these symptoms on the dosage of tuberculin is not always easy to determine, for in many instances they do increase or occur from time to time when tuberculin is not administered. The safest course to pursue is to attribute any sudden marked increase to tuberculin, and to omit several doses, reducing also the following dose. If these symptoms are very slightly increased and the patient is doing as well as usual, the same dose should be repeated several times. If, however, these symptoms become more pronounced, then it is wise to omit several doses and to reduce the next dose. Cough and expectoration are said to be increased at first during the treatment, but such is not the writer's experience. Hemoptysis rarely occurs during the tuberculin treatment, and is best followed by the omission of several doses and a reduction of the next dose. In over 200 patients hemoptysis occurred 11 times in as many patients. In many instances both cough and expectoration are reduced following the injection. Pleurisy rarely occurs so severely as to necessitate omission of many doses and night sweats are rare.

General Symptoms.—The general symptoms are by far the most important in estimating the dose, as they give the first signs of intolerance. Pronounced symptoms should not be expected for they indicate overdosing, but the occurrence of any of the following symptoms, however slight, is of great importance and indicates omission, reduction, or repetition of a dose. Slight headache is one of the most frequent of all symptoms, while severe headache rarely occurs. Even if no other symptom but slight headache is noticed, it is wise to repeat the dose, and severe headache should cause a cessation of the treatment. The same is true of malaise. Pain in the limbs, joints, and back, faintness, giddiness, insomnia, fatigue, rarely occur alone and often are combined, which is also true of indigestion, nausea, and vomiting. Somnolence, restlessness, nervousness, and stimulation are of rarer occurrence, and so, in one way, of less importance. Chilliness may occur without a perceptible rise of temperature. A rash or fever blisters, as a rule, occur only with a pronounced general reaction. Enlarged glands are very infrequent.

The decision whether or not these symptoms may be due to the tuberculin is a matter of moment, and at times of considerable difficulty. Here, as elsewhere, it is always wise to give the benefit of the doubt to the tuberculin as the causative factor and to act accordingly.

The occurrence of two of these symptoms should always indicate a repetition of the dose, and one, if severe, means an omission of one or more doses or a reduction of the dose.

Temperature.—Any of these symptoms may occur without an appreciable rise of temperature, and so must be considered as a much more

delicate and earlier indication of intolerance than rise of temperature. It seems probable that some forms of tuberculin are less likely to produce rise of temperature, without "prodromal" symptoms, than others. This is especially true of B. E., where the patient may feel wretched without any elevation of temperature. B. E. more often produces a sudden rise of temperature when previously none of these symptoms had been noticed. Elevation of temperature has long been looked on as the chief characteristic of intolerance and considered only when the temperature reached 100° F. or more, but the absence of rise of temperature is no sign of the absence of reaction, which often occurs without rise of temperature.

General febrile reactions coupled often with inflammatory organ reactions possess no curative action and are dangerous, especially when severe or repeated. A complete course of tuberculin can be given without febrile reaction, but the majority of patients react at some time. In a course of B. F., not more than three or four reactions should occur in afebrile patients, but in B. E. these reactions will be more numerous (eight to ten). The success of tuberculin therapy depends mainly on the accurate observation of slight departures from the ordinary course, and a rise of a few tenths of a degree in temperature is always of moment. It is difficult to lay down any hard and fast rules, but a rise of one degree or less, even a few tenths, above the usual level, even if only temporary, always means a repetition of the dose, or if accompanied by other symptoms a reduction of the dose (to one fourth to one sixth of the last dose). A greater rise—e. g., from normal to 100° to 101° F.—would mean the omission of one or two doses, and then the indicated reduction.

In no case should tuberculin be given until the temperature has been normal, or at least at the usual level for two entire days, and if the reaction is at all severe, for one week. If, on a repetition of the same dose after a slight reaction, a second reaction occur, it is always well to reduce the dose for fear of producing hypersensitiveness. A progressive rise, however slight, even one or two tenths a day, always indicates cessation of the tuberculin for a time; in other words, never give tuberculin with a rising temperature. This holds also for febrile patients, and until the temperature remains at the same level for at least five or six days, no tuberculin should be given.

It is at times difficult to determine whether or not the rise of temperature is due to tuberculin. As a rule, tuberculin usually produces its rise in about twelve to twenty-four hours, occasionally in six or as late as forty-eight hours, but these limits are so rarely exceeded that a rise of temperature occurring either before four or after sixty hours can usually be attributed to some other cause.

The temperature caused by tuberculin is usually continuous, but may be intermittent and extend over four or five days. The temperature may not rise above the normal limits (99° F.) and yet the range increase. This, if explainable in no other way (e. g., external temperature), should arouse suspicion. The minimum (usually the morning) temperature is of little value if tuberculin is given at night.

Antipyretic Action.—When the elevated temperature is markedly reduced by tuberculin, it is unwise to increase the dose until this effect be lost, but if no effect is noticed the dose should be increased slowly, even until, as Bandelier and Roepke also hold, a slight reaction occurs. Following this the temperature is often lower. Much experience is necessary to carry this out successfully, and longer intervals should be employed, while the usual increases may be maintained.

Increased Susceptibility.—There is in many patients a period of increased susceptibility, when the patient reacts on the usual increase and reacts often two or three times to decreasing doses. This period varies for each tuberculin, being most frequent in the hundredths or tenths of a milligram (solid substance) of B. E., some tenths of a milligram of O. T., some hundredths or tenths of a milligram of B. F. The smallest dose causing reaction was 0.00000005 gm. B. E., 0.0001 c.c. O. T., and 0.00000003 c.c. B. F. In patients who have been subjected to the tuberculin test this increased susceptibility occurs earlier—i. e., to smaller doses—than in others. Once past this point without reaction, it is much less likely to occur. In patients with great susceptibility the same dose should be repeated many times and occasional attempts made to increase it. This susceptibility is more frequent in the febrile, in those with extensive lesions, and in those in poor general condition.

Pulse.—Much importance has been attributed by some (Bandelier and Roepke) to the pulse range, but in the writer's experience it is a less delicate guide than the other symptoms mentioned. An increase of pulse-rate alone, however, usually indicates caution and the repetition or reduction of the dose.

Weight.—The weight is of much less importance in regard to the individual dose than in regard to the treatment in general. A continuous loss of weight, which proceeds until the normal weight for height and age is not maintained, or until the individual's "normal" weight is no longer held, means cessation of treatment until the loss is repaired. The normal weight curve for patients with tuberculosis rises, as a rule, from August to December, fluctuates from December to March, and then falls to August (Brown, '03). This fact should be kept in mind in determining the influence of the tuberculin on the

weight. A loss of appetite means omission of several doses and reduction of the following dose.

From all this it may be seen that whenever any of these symptoms or signs, however slight, arise, one of several courses is open: (1) To repeat the dose, (2) to lengthen the interval, (3) to reduce the dose, and (4) to omit the dose. Tuberculin cannot be given on an "express-train" schedule, and the object is not to reach any definite station where great benefit will be derived, but it is to travel slowly, stopping by each way station, as long as improvement is noticed and pushing on only by slow degrees. The benefit is derived during the journey, not at its end, and just as we cannot all climb to the same altitude, so we cannot all advance as far up the tuberculin scale, though we may derive from it the same benefit.

If, at any time during the treatment, it becomes necessary to change the "brew" of tuberculin, even if the new be made from the same tubercle bacilli, the same broth, and in exactly the same way, it is wise to reduce the next dose to from forty to sixty per cent of the last.

It is manifestly unwise to interrupt any treatment that is doing good, but occasionally it is necessary to do so, and beside requiring a reduction of the dose, the interruption has but little effect.

Complications.—The occurrence of complications—e. g., a perineal abscess, a slight coryza, acute bronchitis, indigestion, etc.—often produces increased susceptibility, and so demands for a time the cessation of treatment. The slightest departure from the ordinary course of events must be considered carefully, and it is often wise to omit one or two doses.

Age.—The age naturally modifies somewhat the dosage, and in children it is wiser to begin with the lower limits of the doses scheduled. Bandelier and Roepke ('08) believe the dose should be one half to one tenth of that for the adult.

Estimation of Patient's Condition.—A patient may be said to be doing well when his temperature and pulse remain normal or become lower and slower (except for one or two days following injection), when the appetite is good, the weight increased, or the normal weight maintained, when the general condition is good and when the pulmonary symptoms are in any wise decreased. On the other hand, if the temperature and pulse become higher and faster for several days, the general condition fail, the appetite become poor, the weight decrease, and pulmonary symptoms steadily increase or recur (hemoptysis, pleurisy), the condition of the patient is unsatisfactory and the treatment should, for a time at least, be discontinued.

Final Dose.—The final dose to be attained in any course of tuberculin depends on the individual, his susceptibility to tuberculin, and the

variety used. No satisfactory proof has been adduced to show that large doses are of more avail than smaller doses, and some patients who can never attain the larger doses seem to do just as well as those with great insusceptibility to tuberculin. There is, however, some connection between tolerance and improvement, for when a patient relapses sensitiveness returns or intolerance may be acquired, and Denys ('05) holds that large doses alone establish solid immunity. Cornet believes that larger doses do help more, but are inadmissible.

Marked tuberculin immunity can be obtained in a majority of patients, but it is still an open question whether immunity to large doses should always be attempted. Sahli ('06) believes that tuberculin immunity is the only thing tuberculin can accomplish. Trudeau, Bandelier and Roepke ('08), and others believe that tuberculin immunity is of great value and should be the object in the treatment. Tuberculin immunity is not immunity to tuberculosis, and animals immunized to tuberculosis show tuberculin susceptibility for some time. Petruschky has long held that large doses of tuberculin are not necessary, that tuberculin immunity is the main object to be attained, and that repeated courses of tuberculin with smaller final doses than usually recommended produce the best effect more quickly. Sahli speaks of the optimal dose for each individual and pays little or no attention to the absolute dosage, regarding only the relative dosage, and believing that tuberculin is the best treatment to avoid dangerous intoxication.

These facts bring clearly before us the objects of tuberculin, and while the weight of opinion seems in favor of producing tuberculin immunity and so aiding the body forces, by removing the toxemia, to overcome the tubercle bacillus, the results by this method have never been as striking as those attained (especially in surgical tuberculosis) by small repeated doses of tuberculin, which, however, does produce some tuberculin immunity. Bandelier and Roepke hold that the best final dose is one that can be borne without reaction, and may not be over 1 mgm. Whether these results rest on increased susceptibility, anaphylaxis, *allergie*, or some hitherto undescribed immunity process, cannot yet be said, but such results have led the writer to believe that the increasing dosage (to large amounts) in the use of tuberculin will be pushed less and less, but that large doses may be necessary in some instances.

Pardoe's ('05) experience with T. R. in tuberculosis of the urinary tract is a striking example of this. He is guided by the symptoms, begins with 0.000002 gm., and increases until a reaction occurs, then reduces the dose considerably and gives the same dose over a long period. His results were excellent and seem to depend on the great irritability of the bladder (possibly to increased secretion of irritants,

following the injection, which, unfortunately, in the case of the lungs is lacking).

These facts suggest that the anatomy of the part—that is, its richness in vascular supply—may have some bearing on the method of administration of tuberculin. The good results obtained by Wright's method are practically all in "surgical" tuberculosis—that is, in parts where the blood-vessels are usually less numerous and where the walls may be less permeable. Pronounced pulmonary tuberculosis, he states, is not suitable for this line of treatment on account of the frequent autoinoculations that occur. When the opsonic index is totally disregarded in this form of tuberculosis and tuberculin immunity is attempted, good results are, to say the least, not infrequent.

Arbitrary limits have been set for many forms of tuberculin (1 c.c. for O. T., B. F., and Béraneck's, 5 mgm. solid substance for B. E., 20 mgm. for T. R., etc.), but why these doses in some instances should not be surpassed has been little discussed. Denys has given up to 10 c.c. of B. F. subcutaneously and 2.5 c.c. intravenously, and Koch recommended 10 mgm. B. E. subcutaneously or a larger dose (20 mgm.) intravenously.

It is, however, a much wiser procedure to limit the final dose by the time required for the tuberculin treatment. A dose that falls short of the usual final dose, that has required nine to twelve months to attain, should, merely on account of the time, be looked on as the final dose, no matter how small. On the other hand, it is rarely wise to exceed the following doses: O. T., 1 c.c.; B. F., 1 to 2 c.c.; B. E., 5 mgm.; T. R., 10 to 20 mgm.; Béraneck's, 1 c.c. The final dose of B. E. should always be diluted and given in two places. Thorner holds that 0.001 c.c. O. T. should never be exceeded in febrile patients. One patient who had showed remarkably little susceptibility to B. F. acquired hypersusceptibility when the dose was increased from 1 c.c. to 1.2 c.c. and reacted to the ophthalmo-tuberculin test.

In a number of patients the writer could never increase the dose beyond a few milligrams of old tuberculin, some thousandths of a milligram of B. F., and some hundredths of a milligram of B. E. (solid substance). For the most part (nine out of eleven) they had extensive lesions, one had an enlarged thyroid with some exophthalmos and a second developed a perineal abscess.

Many authorities advocate the repetition of the final dose a number of times, as long as it does good, with the view of increasing the immunity. Denys ('05) finds, however, that a stage of intolerance is at times acquired in this way, and the writer has seen several instances of it. In this case the dose must be reduced or the treatment discontinued. On the whole, when sufficient time has elapsed since the begin-

ning of treatment, it is wise to discontinue the treatment for a time when the foregoing limits are reached. If, however, the patient feels a lack of the stimulation produced by the tuberculin, it may speedily be begun anew.

Hypersusceptibility.—No schematic plan of dosage can be blindly followed, as individualization plays the most important part in treatment with tuberculin. The proper rate of increase varies for each individual, and also for the same patient at different times during the treatment. The smaller doses are often given with larger increases, and some have noted a period of increased susceptibility which varies for each tuberculin. During this period greater care should be exercised, for the condition of hypersusceptibility may be more readily produced at this time. This condition must be carefully guarded against, as it frequently occurs from overdosage or from giving tuberculin during a period of a slight exacerbation, too soon after a reaction, or during decreased resistance (slight coryza, gastric or intestinal disturbance, etc.).

It is manifested at times by a more or less sharp reaction which necessitates a marked reduction of the next dose. This, however, also produces a reaction, which may follow several doses, each much reduced in turn. The only plan if this occurs is to discontinue the tuberculin for several weeks, or even months, and then begin again very slowly. In one patient, a woman, this hypersusceptibility was produced by the injection of 0.0000001 c.c. B. F. as a first dose several days after a slight attack of pleurisy. In four months of treatment this dose was never again attained, and the treatment had to be stopped on account of the severe headaches it produced.

The "quotient of immunization" of Loewenstein and Rappoport (i. e., relation of the maximum dose injected without reaction and the number of doses necessary to arrive at this dose) is much greater for early than advanced stages.

Value of Small Doses.—The interesting problem of increased susceptibility to serums (von Pirquet and Schick ('05), Rosenau and Anderson ('08)) suggests that a tuberculin anaphylaxis is possible, though the small interval between doses seems to render it improbable. Following the tuberculin test, hypersusceptibility is often present in a marked degree, and Loewenstein has found it to persist for many months. It is not impossible that the increase in dosage, especially at first, is so small for some little while that the mechanism of the body is not adjusted finely enough to appreciate the increase, and so, when very minute doses are used, a hypersusceptibility may be produced when the organism is at all susceptible.

Loewenstein and Rappoport ('04) have shown this to be true for

larger doses of O. T. (0.0002 c.c.) repeated several times, and Koch has pointed out that this phenomenon is very characteristic of tuberculin. This may be the explanation of some reactions to very small doses, and may further explain the good results obtained with small repeated doses of T. R. (Wright and others). It is of interest to note that, in a woman aged twenty-four, with closed infiltration of the right upper lobe, while 0.0001 mgm. T. R. repeated weekly never brought the opsonic index to normal, it apparently produced immunity to O. T. (0.01 c.c. O. T. subcutaneously) and to the ophthalmo-tuberculin test (1 to 200).

Schemata.—Some advocate the continued use of small doses, which seems especially of value in surgical tuberculosis, depending, however, largely on the clinical symptoms for guidance. The majority advise tuberculin to be given in increasing doses, and many schemata have been suggested. The fundamental principles have not yet been fully settled, and whether it is wiser to increase irregularly or by a definite logarithmic scale cannot at present be definitely answered. The majority use an irregular scale, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 20, 30, etc., with increases that vary from a hundred per cent down to eleven per cent. The experience of the writer seems to indicate that reactions occur most frequently when passing from 1 to 2 or from 2 to 3 of this scale. Accordingly, for some time the following scale was used at the Adirondack Cottage Sanitarium: 1, 1.5, 2, 2.5, 3, 4, 5, 6, 8, 10, 15, etc., with increases varying frequently from fifty to twenty per cent. This seemed to prevent reactions at the points indicated. Bandelier and Roepke ('08) use the following doses: 1, 1.5, 2, 3, 5, 7, 10, while Petruschky employs (in milligrams) 0.1, 0.25, 0.5, 1, 2, 3, 4, 6, 8, 10, 15, 25, 35, 45, 60, 80, 100, etc.

Logarithmic Scale.—More recently still, Weber's law of sense-perception has been taken cognizance of, and a logarithmic scale has been constructed.

Concentration and Dosage.—Inasmuch as the effect of the variation in concentrations used has seemed to the writer to exert no influence, Sahli's suggestion of having each higher dilution only twice instead of ten times the strength of the preceding, which is the usual method, seems entirely unnecessary, and requires much time (e. g., for B. F. at least fifteen months for one course). Reaction on going from 0.68 c.c. of one solution to 0.1 c.c. of one ten times as strong has caused no reaction in a large number of cases. The advantage of having each solution ten times the strength of the preceding one is manifest. Sahli gives from 0.1 to 0.5 c.c. of one solution, and then changing to one twice as strong repeats the same dose once, giving consequently 0.25 c.c., and so on. There is no evidence to show that this is neces-

sary. Denys uses a solution ten times stronger than the preceding, and advances usually from 1, 2, 3, 4, 5, 6, 7, 8, 9, to 0.1 of the next solution. At times he advances by 0.1, 0.25, 0.5, 0.75, 1, and so on.

It is intended merely as a suggestion in controlling the dosage, which for each patient varies greatly, according to individual susceptibility, and is of use in giving any tuberculin, for all tuberculins are either in solution or suspensions in fluids. This schema, computed by Pope,[1] is based on a logarithmic scale, and is so arranged that in going from 0.1 to 1 c.c. of any solution two to twelve doses may be employed, while the rate of increase of dose in each case is always constant. The average patient, in the writer's experience, can take the sixth scale (six doses to each solution) without any danger of reaction, but some must go more slowly, and a few, especially during a second course, may go more rapidly.

DOSES (LOGARITHMIC SCALE)

2	3	4	5	6	7	8	9	10	11	12
1	1	1	1	1	1	1	1	1	1	1
3.2	2.2	1.8	1.6	1.5	1.4	1.3	1.3	1.3	1.2	1.2
10	4.7	3.2	2.5	2.2	2.0	1.8	1.7	1.6	1.5	1.5
	10	5.6	4.0	3.2	2.7	2.4	2.2	2.0	1.8	1.8
		10	6.3	4.7	3.7	3.2	2.8	2.5	2.3	2.2
			10	6.8	5.2	4.2	3.6	3.2	2.9	2.6
				10	7.2	5.6	4.7	4.0	3.5	3.2
					10	7.5	6.0	5.0	4.3	3.8
						10	7.7	6.3	5.3	4.7
							10	8.0	6.6	5.6
								10	8.0	6.8
									10	8.3
										10

1. Bouillon filtrate. Interval: twice a week until 0.1 c.c., then once a week. Doses (in cubic centimeters): beginning, afebrile, 0.0000001–5; febrile, 0.00000001–2; final, 1 c.c.
2. Original tuberculin (Koch's). Doses in cubic centimeters. Interval: twice a week, after 0.1 c.c. may be given once a week. Beginning dose same as B. F., final, 1 c.c.
3. Bacillen emulsion:
   a. Doses in solid substance (grams). Interval; twice a week until .001, then once a week. Beginning dose afebrile, 0.0000001; febrile, 0.00000001; final dose, .005.

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[1] The writer takes this opportunity of acknowledging the great assistance he has received in many parts of this article from the late Mr. E. G. Pope, statistician of the Adirondack Cottage Sanitarium.

b. Doses in liquid measure (cubic centimeters). Interval: twice a week until 0.2 c.c., then once a week. Beginning dose afebrile, 0.00001 c.c.; febrile, 0.000001 c.c.; final dose, 1 c.c.

4. Tuberculin R.:
   a. Doses in solid substance (grams). Interval: twice a week until .005, then once a week or less frequently. Beginning dose afebrile, 0.0000001; febrile, 0.00000001; final dose, 0.01 to 0.02. Dosage after 0.01: 0.012, 0.015, 0.017, 0.02.
   b. Doses in liquid measure (cubic centimeters). Interval: twice a week until 0.02 c.c., then once a week or less frequently. Beginning dose afebrile, 0.00001 c.c.; febrile, 0.000001 c.c.; final dose, 1 to 2 c.c. Dosage after 1 c.c.: 1.2, 1.5, 1.7, 2 c.c.
5. Béraneck's. Doses in cubic centimeters. Interval: twice a week. Beginning dose afebrile, 0.05 c.c. of $\frac{A}{32}$ solution; febrile, 0.05 c.c. of $\frac{A}{64}$ or $\frac{A}{128}$; final dose, 1 c.c. of T. Bk (pure tuberculin).

SELECTION OF PATIENTS

Theory of Action.—The theory of action of tuberculin has much bearing on the selection of patients. Formerly, when Koch held that tuberculin caused a sloughing off of the tuberculous areas, all patients except those in early stages were soon considered from this standpoint as unsuitable, many of whom now are subjected to the treatment. On the other hand, the acuteness of the process, formerly disregarded, now plays an important part. Tuberculin is not an antitoxin, but a toxin, and the process of "tuberculin immunization" is not passive but active. The majority of observers (Trudeau and Baldwin, etc.) have failed to find any antitoxin in the serum, either during tuberculosis or during tuberculin treatment. The struggle seems closely connected with the cells, probably those about the foci, and some observers (Wasserman and Bruck) have noted an antituberculin in the tissues.

An incubation period of six to twelve hours intervenes after the injection of tuberculin before a rise of temperature occurs. What occurs during this period of absorption and "attuning" of the system is impossible to say, but it may be that tuberculin acts as an "enzymogen," which in time sets free from the cells about the tubercle sufficient toxin of digested tubercle bacilli to produce the reaction. By this theory it is easy to understand how tuberculin would prove only of injury to acute cases already overwhelmed by toxin. It is also easy

to see how overdosage, by liberating too much toxin, may overwhelm the organism, interfere with nutrition, and so produce disastrous results. The gradual liberation of the toxins of the digested tubercle bacilli, brought about by small doses of tuberculin, may free many already overloaded cells about the focus, thus enabling and stimulating them to attack and digest any bacilli escaping from the lesion, and permitting and stimulating the connective-tissue cells to act more rapidly in forming a capsule about the focus.

In the ordinary course of the disease, according to another theory, the tuberculin is formed so gradually that the whole organism is rarely stimulated to the formation of any antibodies; in the tuberculin treatment a large amount is thrown into the circulation at once, and so the whole system is immunized in some way against tuberculin. This may permit the bacteriolytic properties of the tissues to exert themselves, whereas before they were too weakened to do so; in other words, it permits an auto-immunization to take place.

The explanation of the failure of many patients in far-advanced stages to react to tuberculin may be that a system, already saturated with toxin, reacts less readily, if at all, to an increase of the toxin, and in these cases the cells are so affected that they can no longer respond to stimulation. They can, as Mitulescu says, neither take in material necessary for reconstruction nor protect themselves against the action of poisonous substances. Tuberculin, Sahli believes, is not merely a specific, but, like digitalis in cardiac disease, a functional therapeutic means which acts only in a definite way on the toxin susceptibility of the organism. The natural healing powers are permitted to act after tuberculin has combated the toxemia.

It is of interest to recall, as Loewenstein has pointed out, that almost all diseases in which immunization takes place are acute diseases. The struggle is sharp and quickly decisive, ending before the cells lose their powers of resistance (antitoxin formation). Tuberculosis is a chronic disease whose pathogenicity depends rather on the ability of the tubercle bacillus to live and multiply in the tissues, than on the potency of the poisons they produce (Vaughan). The nutrition is profoundly affected by this poison or toxin, a fact which gives the pulmonary form its vulgar name—consumption. The toxemia usually progresses so slowly that its advance can scarcely be noted from day to day. Small quantities of the toxin of the tubercle bacillus affect man profoundly, while he has usually fairly good resisting powers against the tubercle bacillus itself. Such facts would suggest that could immunity to tuberculous toxin be produced, man in many instances could overcome the tubercle bacillus. However this may be, remarkable tuberculin immunity may be acquired and maintained for long periods by suitable

repetitions of the treatment. (See Repeated Courses.) Immunity to tuberculin, unfortunately, does not mean immunity to tuberculosis, as many experiments have shown, and, on the other hand, susceptibility to tuberculin does not always mean lessened resistance to a previously acquired tuberculosis. The results obtained in patients with surgical tuberculosis immunized to tuberculin are rarely, if ever, so striking as many instances reported of patients treated by Wright's method, but many have been unable to substantiate these results.

Symptoms and General Condition.—From this we may conclude that all patients with acute tuberculosis, all patients whose nutrition is so profoundly affected that little response is possible, are unsuited for tuberculin treatment. When the general condition is far below normal every effort should be made to improve it, and at the same time to reduce the temperature and to abate the symptoms, before resorting to the use of tuberculin, but Bandelier and Roepke believe that if the time is short (e. g., on account of financial resources) tuberculin should be begun at once and nothing else omitted to improve the condition of the patient. The results in such patients are, of course, as Petruschky ('04) points out, much more uncertain than in those in incipient stages.

Elevated Temperatures.—Most observers select only those patients whose symptoms indicate an arrest, possibly only temporary, of the disease. For this reason, elevated temperature is said to be a contraindication to the use of tuberculin, but recent experience shows that this is not true for all patients with elevated temperature. Many patients who persistently have a slightly elevated temperature ranging from normal or below to 99.5 to 100° F., presenting at the same time no other very marked symptoms, do remarkably well with tuberculin, and often regain a normal temperature. If, on the other hand, the temperature be persistently high, rarely falling below 100° F. for a period of some weeks, tuberculin can accomplish little. On the whole, it is rarely a wise procedure to give tuberculin to any patient whose temperature reaches 101° F. or over unless all other symptoms are distinctly favorable, and too much must not be expected in any case. Koch, Goetsch, Holdheim, etc., oppose the use of tuberculin in patients with fever.

A persistently rapid pulse after prolonged rest is a contraindication in most cases to tuberculin. Such patients do badly, and while not harmed, frequently derive little benefit from tuberculin. Cough or expectoration in themselves, unless excessive, are of small importance in connection with the selection of patients, but, when excessive, great caution should be used if tuberculin be administered at all. Slight dyspnea is of little moment, urgent dyspnea is a contraindication. A tendency to hemoptysis is no contraindication, and dry pleurisy, existing

for some time, is of no significance unless very painful, and if not increased by tuberculin, need be little considered. Pleurisy with effusion after the acute stages are over need not cause any interference with the treatment. A feeling of oppression in the chest, unless arising during the treatment, is no contraindication. Emaciation and anorexia are, as previously stated, contraindications.

Complications.—Most complications have with many men little influence on the selection of patients, but the prognosis, which is always worse in such cases, should always be considered. Meningitis is an absolute contraindication, but Vernet ('07) has stated that he cured one case in a child, and Maurange ('96) noted marked improvement in another. The occurrence of a true nephritis (not the presence of a few casts in centrifugalized urine or the slightest trace of albumin) is a contraindication in most cases. This does not hold for tuberculous nephritis, where many good results have been obtained (von Ruck, Whipple, and Duriac). Diabetes and cirrhosis of the liver are absolute contraindications for many who state no reason but a bad prognosis. Marked nervous symptoms, hysteria, neurasthenia, exophthalmic goiter, considered by some as contraindications, necessitate care, but many of these patients seem to derive from tuberculin the mental leverage necessary to carry them over rough places, as it enables them to attribute to tuberculin many slight exacerbations which otherwise would cause great mental disturbance. This is a factor of no little importance.

Epilepsy, if not a positive contraindication, would necessitate the greatest care. Syphilis is no contraindication (Heron, Thorner). Valvular disease of the heart, if any history of noncompensation be obtainable, or if degeneration of the heart muscle or blood-vessels occur, is a contraindication. The occurrence of secondary infections, which markedly influence the general condition of the patient, is a contraindication. Sahli believes that "mixed infection" is the scapegoat for poor results, while Koch opposes the use of tuberculin when there are "morbid processes" caused by streptococci, staphylococci, pneumococci, influenza bacilli, etc. The poisons of the tubercle bacillus would seem from von Korczynski's ('05) work to increase the virulence *in vitro* of some organisms (colon, streptococcus, staphylococcus). Pregnancy is no contraindication, and Petruschky, basing his opinion on 11 cases, 10 alive and well and one dead from pneumonia with healed tuberculosis, holds that patients who have been treated with tuberculin can marry without risk. Roepke strongly advises the use of tuberculin in these cases.

Physical Signs.—The physical signs, except when extensive softening and ulceration have occurred, need little consideration. If such be the case, little can be hoped from tuberculin treatment, and a wiser

course is to refrain from its use, though if such a patient insist it should be given. Patients whose extent of physical signs corresponds to stage III Turban, may go through the entire course without the slightest reaction. When the physical signs are extensive the general condition must be good and the symptoms slight, or tuberculin is contraindicated. The location of the physical signs is of little importance.

Duration of Disease.—The duration of the disease is often an indication for tuberculin. The patient has tried the hygienic-dietetic treatment, a change of climate, and what not, without permanent benefit or even marked improvement. The disease has remained stationary or possibly advanced slightly at infrequent intervals. Such patients are preëminently suited for tuberculin, which should always be exhibited to them. The argument that tuberculin should be reserved only for such patients as fail to improve under other forms of treatment is an acknowledgment of lack of faith in tuberculin, and if tuberculin be of value for these patients it is of much more value for patients in incipient stages. It is true, as Spengler states, that in the incipient stages it is impossible to determine what value tuberculin possesses, but he believes that in more advanced stages his results leave no doubt as to the great value of tuberculin. A few patients, even in the earliest stage, cannot take tuberculin except in the most minute doses, but these, as Sahli says, are not always the most unfavorable.

Age.—The question of age in the selection of patients need be little considered in its lower limits, as children often do remarkably well (Petruschky), though Vaquier and Ganghofner obtained only "fair" results. In patients past fifty years especial attention should be paid to complications in the cardiac or renal systems.

Prophylactic Use.—Members of phthisical families, even though they present no signs or symptoms of disease, are often benefited by tuberculin (Sahli). Patients who must continue work should not for this reason alone be refused tuberculin.

Advice for Inquiring Patients.—The advice to be given a patient who inquires about tuberculin is of considerable moment. He should be told that tuberculin properly given will not harm him, may produce no immediate results, but may act very beneficially both in regard to the future (relapse) and on the symptoms. It should be clearly stated to him that treatment for two or three months is of little avail, and that it means six to nine months at first, and later a repetition of the treatment.

SELECTION OF TUBERCULIN

The selection of a tuberculin is most difficult. The only perfect immunity obtained in animals has been by use of the attenuated cul-

tures of the living human tubercle bacillus, which would suggest that the tubercle bacilli under stimulation of the cells and juices of the body produce some toxin not otherwise generated (Welch). The results have been especially favorable in cattle, which has led several observers to the use of tuberculin from the bovine strain of tubercle bacilli, or, indeed, to the use of the bovine tubercle bacillus itself (Spengler, '05). Klemperer ('05) injected himself and five patients without apparent harm with a virulent bovine tubercle bacillus, but obtained no striking results. Moeller, after immunizing himself with tubercle bacilli, passed through a blindworm, inoculated himself without effect with an attenuated tubercle bacillus which apparently failed to kill guinea pigs. His experiment proved little. Friedman carried out the same experiment in animals, using a turtle tubercle bacillus, which was later found to be virulent in some cases.

In tuberculosis in man the tubercle bacillus is already in the body, and it may be questioned whether the inoculation of more tubercle bacilli would prove of as great value as some hold. The normal and tuberculous animals react very differently to the tuberculous toxin, and the use of living tubercle bacilli in tuberculous cattle has not shown striking results. In any case it is not justifiable to subject man to such procedures.

The use of homologous tuberculin or vaccines in tuberculosis has met with little favor, and the best immunizing results have been obtained with heterologous bacteria (attenuated human strains against virulent bovine strains). Loewenstein and Allen believe that homologous tuberculin or vaccines should be used, and Haentjens-Putten and Krause ('07) have employed them, while von Eberts believes they are impracticable in skin lesions. C. Spengler has claimed astounding results by the use of allotoxins; when the infection is with human tubercle bacilli, as is usual, he uses bovine tuberculin and *vice versa*, and when a dose of 100 mgm. is reached, he alternates human and bovine tuberculins and reports agglutination in strength of 1:2,000. Wolback and Ernst found no difference experimentally in the action of human and bovine tuberculins.

Theoretically it would seem sufficient to immunize man against the toxin (tuberculin) of the tubercle bacillus, for as yet no perfect bacterial immunity has been produced by any other agent than the living bacillus, and by doing this enable him to overcome the tubercle bacillus itself against which he has considerable resistance. The use of nontoxic split products of the tubercle bacillus of Vaughan and of the nastin of Deycke and Reschad Bey, possibly also of von Behring's tulaselaktin, are all attempts not yet proved successful at bacteriolytic action.

Judging from the results obtained up to the present time there is apparently little difference between the action of the various tuberculins when properly given, as all probably contain the specific tuberstance. The original tuberculin has in the hands of many observers given just as reliable and satisfactory results as any of the later modifications. No satisfactory proof has been adduced to show that the culture fluid contains any substance not in or about the body of the tubercle bacillus. In fresh cultures tubercle bacilli rarely lie immediately side by side, but are separated by some substance, which, dissolved in NH_4Cl, is capable of producing the tuberculin reaction (Baldwin). Schmoeller ('05), quoting Denys, Koch, and Klebs as his authorities, states that the specifically acting substances are set free in the culture fluid, while the insoluble substances retained in the bacterial bodies have only inflammatory and pyogenic properties. Analogy with other bacterial vaccines would lead us to believe that heat may destroy, in part at least, the immunizing substance, and it certainly produces a precipitate. For these reasons it would seem best, theoretically, to employ an emulsion of pulverized tubercle bacilli, killed at 59° F. by repeated heating, in the unheated culture fluid, rendered sterile by filtration through porcelain. This would mean, expressed in other terms, B. E. in B. F.

Next in theoretic value would stand B. E., an emulsion which produces at times an unexplainable reaction, and so presents more difficulty in dosage, and T. R. an emulsion, acting similarly, of pulverized and water-extracted tubercle bacilli. It is of interest to note that Wright's results have been obtained with minute doses of T. R., while Goetsch ('01) was never able to obtain a complete disappearance of tubercle bacilli with T. R., and had to resort to O. T., and Bandelier found that T. R. produced much weaker agglutination than B. E. Theobald Smith considers virulent uncrushed tubercle bacilli, killed by moderate heat, as the best vaccine. Jousset has obtained good results with a culture that was allowed to die in the culture fluid. B. F., which is unheated, diluted O. T., is a weak tuberculin less likely to produce fever than general symptoms when carefully given, and an excellent form for anyone beginning the use of tuberculin. Spengler's TOA is really concentrated B. F. without the addition of thymol or phenol, which he believes in time gradually reduces the strength of the ordinary B. F. His TOA produces, he says, fewer cardiac symptoms than the carbolized B. F. Sahli is as strong in his praise of Béraneck's tuberculin as Denys is of B. F.

Klebs was the first to attempt to separate the beneficial from the harmful components of tuberculin, but his tuberculocidin, administered chiefly by mouth, either with or without selenin (a derivative of his

Diplococcus semilunaris), has been little used. Von Ruck's watery extract finds its greatest field among the general practitioners of the Southern States.

Maragliano's work would suggest that B. F. might possess a hypothermic action, and in some instances this undoubtedly is true. Other observers attribute the same action to O. T., T. R., B. E., Béraneck's product, etc. Bandelier and Roepke believe that B. E. is the best tuberculin, and that T. R. is to be preferred to O. T. when the antipyretic effect is desired. The separation of T. O., which Koch thought to be the chief hyperthermic constituent of the tubercle bacillus, from T. R. does render the latter of value in some patients who are unable to take O. T. (Goetsch, '01; Bandelier and Roepke, '08), and the same may prove to be true in the case of other forms of tuberculin than O. T.

Finally, it may be added that every form of tuberculin has its adherents, who often publish strong if not extravagant claims for the preference. This fact leads many to believe, as has been stated, that little real difference exists between many of the tuberculins (Sahli, '07).

DURATION OF TREATMENT

Tuberculosis is a very chronic disease, in many instances extending over four or five years before full recovery or death ensues. The hygienic-dietetic treatment, the so-called sanatorium treatment, has clearly proved that long periods of time (three or four years) are necessary to insure permanent recovery. Few patients, especially among the poorer classes, can afford to devote so much time to seeking health, and all recognize to-day that except for the very well-to-do, residence in a sanatorium until permanent recovery takes place is out of the question. Many sanatoria limit the term of residence to three to six months, and recognize fully that their chief purpose is to start well the recovery toward health and, what is more important, to inculcate ingrained habits of self-restraint and hygienic living. Tuberculin treatment cannot be completed at such institutions, and many question the advisability of beginning it at all.

The same thing applies to the tuberculin treatment that applies to the hygienic-dietetic treatment at these institutions; neither can be completed, but the patients can be so trained that on their return home they can, when tuberculin has been found to be helpful, have their home physician continue the treatment, even while they are at work. They have learned how they should feel; they quickly recognize the essentials governing the increase of dose or the cessation for a time of the treatment. In this way they can aid immensely their family physician in conducting the tuberculin treatment at home or even, as

some physicians have permitted, although this is not advisable, continue to give tuberculin to themselves under the direction of the sanatorium physician.

From what has been said, it is clear that the majority of physicians who give tuberculin hold that it should be given, even in incipient stages, over a period of at least six months, and after an interval of three to six months a second and shorter course should be begun. It is neither necessary nor advisable to discontinue tuberculin in patients, especially those in advanced stages, who at the end of six or nine months are doing well. It may be continued for twelve to fifteen months with benefit, but if given too long hypersusceptibility may occur. Petruschky believes that by stopping treatment when he reached a dose of 30 to 50 mgm., and awaiting the return of susceptibility to small doses, he shortened much the length of the treatment.

Repeated Courses.—But little evidence is at hand on which to base judgment of the value of repeated courses of tuberculin, first suggested by Petruschky. It is well recognized that every tuberculous patient harbors in his body tuberculous foci of different ages, and for this reason any treatment, unless it be continued or repeated for months, has been, except in rare instances, of little avail. Theoretically, tuberculin should be continued with intermissions of longer or shorter duration until the patient is cured or derives no further benefit from the treatment. It is not always easy, after completing a course of treatment, to decide when a new course should be begun. If tubercle bacilli still occur in the sputum, a second course should be begun in three or four months. If, after a few months' interval, the patient begins to feel languid or to show any other signs of renewed activity, a second course should be begun.

Tuberculin Test.—If, however, tubercle bacilli remain absent or no change in the physical signs or symptoms occur, the decision is more difficult. Petruschky has found that in patients with tubercle bacilli in the sputum, tuberculin susceptibility (to 0.010 c.c. or 0.001, 0.005, 0.010, 0.020 c.c. O. T.) returns in about an average of three months, and he insists that when tuberculin susceptibility returns the patient is not cured and should take more tuberculin. If absent, the test should be repeated at the end of three more months, and if reaction takes place tuberculin is given. Koch upholds Petruschky, and C. Spengler uses up to 10 mgm. for this purpose. Goetsch followed a similar course, but subjects the patient to 50 mgm. O. T. Denys, who prolongs his first course of B. F., found reaction to 0.005 to 0.010 c.c. of O. T. in three patients after five, twelve, and nineteen months respectively.

The recent ophthalmo-tuberculin test may prove to be of value in this connection, and in four patients who had taken 1 c.c. B. F. it

remained absent for three or four months. It is interesting to recall in this connection the patient who after repeated doses of 0.001 mgm. T. R. failed to react. Sahli depends, in a decision about a second course, partly on the slowness and length of the first course, and at times gives it prophylactically.

The second course of tuberculin can be begun with higher doses and given more rapidly than the first (Denys, '05).

TREATMENT DURING THE ADMINISTRATION OF TUBERCULIN

Sanatorium.—A patient with tuberculosis should be under the best hygienic-dietetic conditions possible, and these can for most patients be obtained more readily in sanatoria. Many, however, cannot remain long enough at a sanatorium to complete the tuberculin treatment, and such patients must be treated at home.

Rest and Exercise.—It has been advised by some (Goetsch) that the patients remain in bed the day of the dose and the day following. Were this always necessary, it would debar many patients who have obtained apparently great benefit from tuberculin. It is advisable, when possible, to curtail the exercise on the day of the dose and the following day, but that this is not necessary many who give tuberculin to patients at work have proved (Denys, Krause, Holdheim, Heerman, Poppelheim, William Meyer, etc.). In one instance a patient who had been exercising for two hours a day began, when taking 0.1 c.c. B. F., to work six to eight hours daily. He continued at work and completed his course of tuberculin without reaction, but greater care should be exercised in dosage under these conditions. Tuberculin, therefore, may be administered without injury to the patient under somewhat adverse conditions, providing always that the patient get sufficient food.

Rise of Temperature.—A rise of temperature to 100° F. for more than two hours always means absolute rest in bed for one or two days, or until the temperature is normal for at least one day, and a patient with a tendency to reaction should remain at absolute rest either in his reclining chair or in bed the day following the dose. The severe headache accompanying some reactions is best treated by an ice bag on the head, but codein sulphate (gr. $\frac{1}{4}$ q. 2 h.) may be used. Antipyretics should be used sparingly if at all.

Medicinal.—In conjunction with tuberculin many substances have been administered. Maragliano uses a serum and tuberculin in alternating doses. Rudolph gives calcium carbonate or phosphate in large doses, which he thinks is deposited in the tuberculous focus during the "organ" reaction. Poeppelmann rubs in iodin, Wolff used iodin,

Maréchal injects creosote phosphate, and Bernheim and Quentin and Pegurier confirmed Maréchal's statements.

Vaccines.—Vaccines made from organisms recovered from washed sputum have been employed, and Klebs advocates the use of selenin, an extract of the *Micrococcus catarrhalis* in conjunction with tuberculoidin.

EFFECTS OF REPEATED DOSES

Weight.—Tuberculin seems to exert little influence on the general condition and weight as long as reactions are avoided, or, indeed, an occasional slight reaction may occur with little if any harm. Mitulescu found, following the use of T. R., a retention of the nitrogenous and phosphorous substances and so increased nutrition, and Denys ('05) thinks B. F. increases the appetite. Patients who were gaining weight in the writer's experience seemed to continue to do so, and those losing weight were rarely affected. A few patients about held their own during treatment, but when it was completed showed a marked gain.

Blood.—Erythrocytes.—An increase in the number of the erythrocytes after small doses has been noted (Rebaudi and Alfonso), and following severe reactions a reduction in the erythrocytes may occur. No study of the blood platelets has been made in this connection.

Leucocytes.—In rabbits Kinghorn ('02) observed first a leucopenia, then a leucocytosis, while a study of this subject in patients at the Adirondack Cottage Sanitarium led Lupton and Brown to conclude that while 10,000 per cubic centimeter was rarely reached, an essential increase was often present. In none of their cases was a marked leucocytosis present, and in only one or two cases was a leucopenia even suggested. The differential count showed that for rabbits the increase occurred in the amphophile cells while the lymphocytes were decreased (Kinghorn), while for man the increase, according to Botkin ('92), occurred in all varieties. He obtained this when no fever was present, but he examined only three patients. Tschistowitsch ('91) found a leucocytosis after tuberculin and Bischoff ('91) found a leucocytosis in pulmonary tuberculosis after tuberculin, but says it often occurs without tuberculin. Arneth, believing that the neutrophilic leucocyte passes through definite stages from a cell with one nucleus (young) to a cell with five divisions (old), has worked out definite "blood pictures" for health and for pulmonary tuberculosis, which differ widely in that the younger neutrophiles are in excess in pulmonary tuberculosis over the older and better "trained" cells, and as the disease progresses become more numerous still. Tuberculin, he believes, restores the normal

equilibrium. A few have confirmed his work in part. (Klebs, A. C. and H., '06.)

Serum.—The blood serum plays the most important part in the changes produced by tuberculin. Arloing and Courmont noted the agglutination of a homogeneous culture of tubercle bacilli by the serum tuberculin and first advocated his bacillary emulsion because it produced more agglutination than any other tuberculin. The most important work, however, on the serum has been that of Wright, whose tuberculo-opsonic index has been fully discussed elsewhere (Appendix). The opsonic index to the tubercle bacillus is based on the number of tubercle bacilli "phagocyted" by the polymorphonuclear cells—cells probably little concerned in acquired immunity in animals. It has not yet been clearly proved that these cells give a true index of the action of the mononuclear cells, which apparently play the important rôle in the immunized animals. During the injection of small, well-spaced, well-measured doses of tuberculin (T. R.), the tuberculo-opsonic index, after a preliminary fall (negative phase), not always present, rises (positive phase) and remains high for some days (high tide of immunity). This opsonin is present in normal individuals, and is apparently complement, as it is thermolabile, while in tuberculous patients it is thermostable and is probably a specific amboceptor.

Blood-pressure.—The blood-pressure is lowered after large experimental doses, but is unaffected by therapeutic doses (Bauer, A. F. Miller).

Untoward Results.—The untoward results of tuberculin as classified by Thorner ('94), at the close of the period of "tuberculin delirium," are collapse, impetuous reaction, dangerous swelling around tuberculous parts (e. g., larynx and trachea), nephritis, severe hyperemia of the skin and brain, hemorrhages (of the lungs?), pneumonia, inflammation of the pleura, mobilization of the tubercle bacillus, and general tuberculosis, and, according to Virchow ('91), perforation of the intestine when tuberculous, and of the lung. Heron ('01) mentions several unfortunate and fatal accidents following tuberculin. A. Fraenkel ('91) reported a case where the patient developed a tuberculous ulcer of the tongue that rapidly progressed in spite of tuberculin, which, however, was given while the patient had a temperature of 101.3° F. daily. Krause ('00) has carefully reviewed the cause of the early failure of tuberculin and decided that it was due mainly to the severe cases selected and the doses and intervals used.

Some of the untoward results are unquestionably merely coincidences. The writer had decided to give two patients tuberculin, and in the meantime one had a severe attack of exudative pleurisy, the other an attack of hemiplegia. Trudeau, Latham, Marmorek,

Denys, Campbell, Brieger, Moeller, and others have all had such experiences.

Koehler ('05) had two cases of local gangrene after the use of tuberculin, but later found that he had employed a diluent which contained a little H_2SO_4. Sehrwald had also a case of circumscribed gangrene following tuberculin. In the writer's experience a sterile abscess developed after a large dose of B. E., but no other untoward symptom occurred at the site of the injection in about 10,000 doses.

Mobilization of Tubercle Bacilli.—The strongest objection urged against tuberculin has been that it mobilizes the tubercle bacillus, and many have attempted to verify Liebmann's ('91) work, which disclosed countless numbers of tubercle bacilli in the blood following tuberculin. In 141 patients tubercle bacilli were found 56 times. Barling and Wilson found 2 tubercle bacilli in 1 and none in 3 preparations from one girl. Prior was able to find none in his patients, and Guttmann and Ehrlich none in 29 patients. Kossel ('91) in 800 preparations found 3 tubercle bacilli, 1 doubtful and 2 unverified. He also examined Liebmann's preparations, found no tubercle bacilli in cells, but in dirty areas, and accused him of using dirty slides formerly used for sputum examinations. Lustig (quoted by Kossel) found tubercle bacilli in the blood in miliary tuberculosis, and more recently several observers have found with improved technic (inoscopy, hemolysis, etc.) tubercle bacilli in the blood in patients not subjected to tuberculin. Such results show that tuberculin has no effect on mobilizing tubercle bacilli, for they occur as frequently in patients treated without tuberculin as in those with if we except Liebmann's work, which has never been confirmed and is probably valueless. Furthermore, experimental (Baldwin) and clinical (Petruschky, Trudeau, Wilkinson, Moeller, Beck) evidence has failed to show that tubercle bacilli may be disseminated by the use of tuberculin.

Sputum.—The cough and sputum are frequently increased after tuberculin, and a feeling of oppression is also often present, suggesting a congestion. A preliminary increase of sputum, which may be more pustular and "dirty," is thought by some to precede the following diminution in amount. C. Spengler believes this increase may be due to the fact that tuberculin produces about the tubercle a specific seroplastic inflammation. The number of leucocytes in the sputum is thus consequently increased. Denys also has noted this.

No effect can be detected on the tubercle bacillus other than what usually occurs as the sputum lessens (i. e., tubercle bacilli may be more numerous in the greatly reduced quantity, or, in other words, an apparent increase with a probable real decrease of the number). The virulence is unchanged and the morphology unaffected, though Denys be-

lieves the tubercle bacilli are longer and more granular, and clumping is said to be more frequent. Closely similar results have been obtained by Pane working under De Renzi, who has fully reviewed this subject up to 1894. Vierling could detect no definite changes in a case he carefully studied. Phagocytosis has been found, following the injection of tuberculin, to occur less frequently by Allen, more frequently by Denys and Buchanan.

Urine.—The urine shows few changes except after severe reactions, when it is increased and may present slight traces of albumin and a diazo-reaction. The phosphates and chlorids are increased and urea decreased after the first injection. Salomon ('04) in experiments on animals found that it was very difficult to produce the sclerotic kidneys, long thought to be due to the action of tuberculin (diffusible poisons of the tubercle bacillus), and attributed the kidney degeneration in man, in part at least, to the action of other toxic substances. Grancher and Martin found that their rabbits, partially or wholly immune to virulent tubercle bacilli, almost certainly died sooner or later of a nephritis, similar to the epithelial glomerulo-nephritis of scarlet fever. According to Rappin and Fortineau, and Ramord and Hulot (quoted by Lubarsch and Ostertag), the kidney epithelium often shows after the experimental use of tuberculin pronounced signs of degeneration, due probably to its toxic action. Denys has never observed albuminuria in any of his patients treated with B. F. Three patients out of over 200 during treatment with tuberculin by the writer developed nephritis; the tuberculin was stopped and one made a good recovery. The other two were in a far advanced stage. Another patient developed a fatal nephritis one year after leaving the sanatorium, during which period he worked hard and rapidly declined. L. Spengler believes T. R. is preferable, as he found no renal complications following its use, while after O. T. eight per cent of his patients had albuminuria. C. Spengler states that albuminuria is not uncommon after bovine tuberculin. De Renzi ('94) reviews the work done on the urine after the use of tuberculin and found the diazo-reaction and albumin more frequently and urobilinuria almost constantly present.

Elevated Temperature.—The effect on the symptoms, except elevated temperature, is very difficult to determine, and even if no results are apparent it is wise to continue the treatment if no bad results are noted. Tuberculin exerts on the whole no marked effect, and the improvement is no different from what occurs in patients improving and not taking tuberculin—i. e., it is by leaps and bounds, rarely steadily onward to cure. A very marked and immediate effect is seen on the temperature in some cases, especially when it does not rise above 100° F. Following each dose of tuberculin the temperature falls, and

in some instances this is gradual until the temperature becomes and remains normal. In others the temperature is lowered only as long as tuberculin is administered.

Zupnick, who is opposed to tuberculin, frankly acknowledges its antipyretic effect. Aufrecht, Koch, Denys, Elsaesser, and many others have noted a similar action. Rosenberg was unable to detect any antipyretic effect.

Hemoptysis.—Bandelier and Roepke believe that practically all symptoms are improved by tuberculin and have never had a recurrence of hemoptysis, attributing this to a new distribution of the blood due to hyperemia, which relieves the weakened vessel. Goetsch has never seen hemoptysis occur for the first time during tuberculin treatment, while Grasset has in one case. It is a striking fact that tuberculin does not produce hemoptysis more frequently when we consider the finer structure of the lung and the congestion produced by tuberculin.

In all, 11 instances of hemoptysis more or less connected with, or at least following, tuberculin (in one to three days), have come under the writer's notice. None was severe, and most slight or "streaky." In 8 a previous hemoptysis had occurred, and in only 2 was there any marked febrile movement, while in 4 the temperature remained normal. In 3 patients it rose to 99.4°, 99.6°, and 100° F. respectively. When it is considered that in over 200 patients, many well advanced, receiving about 10,000 injections, many of whom had had previous hemoptysis, this symptom was present only 11 times, it seems as if the few hemoptyses might be looked on, in part, at least, as coincidences.

Physical Signs.—The physical signs present much fewer changes than many hold, and improvement when it takes place differs in no way from its usual course. Increase of physical signs after the use of tuberculin occurs in some cases, possibly more often after large doses or certain forms of tuberculin (watery extract). The local or "organ" reactions occurring in patients with secondary infection (really advanced disease) are always serious.

Complications.—The occurrence of complications in patients taking tuberculin has seemed to the writer to be less frequent than in those subjected only to the hygienic-dietetic treatment, and Bandelier and Roepke have noted the same thing. When they do occur the course, unless benefited by tuberculin, seems to run as usual. Laryngitis and all forms of surgical tuberculosis are apparently benefited by small, carefully selected doses of tuberculin when the patient is in a suitable condition to take tuberculin.

Pathologic Changes.—Other pathologic changes produced by tuberculin are said to be cell proliferation if moderate doses be used, but

when given in large doses fibrosis occurs about the foci, in the kidneys, and in the liver. Endarteritis and periarteritis have been found. An anatomic study, made by Pearson and Gilliland, showed in all of their treated animals (cattle) that the lesions had retrogressed, were quiescent, encapsulated, but contained living tubercle bacilli, while in the untreated there was no encapsulation.

Experimental Results.—The experimental basis for many tuberculins is of considerable interest. Koch at first claimed excellent results in guinea pigs with O. T. which later were not confirmed. T. R. and B. E. have given, like O. T., only partial immunity in small animals, and some obtained none (Baumgarten, Arloing, Courmont, and Nicolas). These, as well as many other tuberculins not used clinically, have all been fully tested on animals. The experimental value of von Ruck's watery extract rests on the results obtained in six inoculated guinea pigs which outlived the controls, but were killed by a dog and not examined. Hirschfelder in his first paper based his claims on the experimental results obtained in one dog. Sahli states that the claims for Béraneck's tuberculin are supported by excellent (the best, he believes) experimental evidence. Denys's tuberculin has no experimental backing, as the author believes animal experimentation of little value in proving the worth of tuberculin.

A careful survey of the whole field of animal experimental research on the value of tuberculin gives definite proof that tuberculin affords no bacterial immunity, but often prolongs markedly the lives of the treated animals, even the most susceptible, retards the development of the disease in its earlier stages, and produces changes in the lesions which demonstrate an attempt at healing (Trudeau, '03, '06).

RESULTS

The results obtained in the treatment of pulmonary tuberculosis by tuberculin would indicate that this treatment is of value, and the view of the majority of those who administer it is decidedly in its favor, although some admit that their figures do not always bear out their optimistic opinion. Tuberculin, Petruschky ('99) believes, can produce one of five things: (1) acute intoxication, (2) chronic intoxication, (3) fluctuation between immunization and intoxication, (4) regular immunization, (5) lack of results due to a too timid method of procedure. Sahli ('07) holds, and with considerable reason, that the results are (1) cure (only in the earliest stages), (2) compensation (equilibrium, the disease neither advances nor retrogrades), (3) the disease slowly advances, (4) no results. In many instances it is manifestly unfair to expect much from the use of tuberculin. The writer for several years

selected severe types of the disease, expecting a steadily downward progress, but on the whole such patients have done remarkably well, much better than he dared hope. Such results are difficult to record, can hardly be expressed in figures, but suggest that there is reason for the belief in tuberculin that is gaining ground (see Figs. 148 to 151).

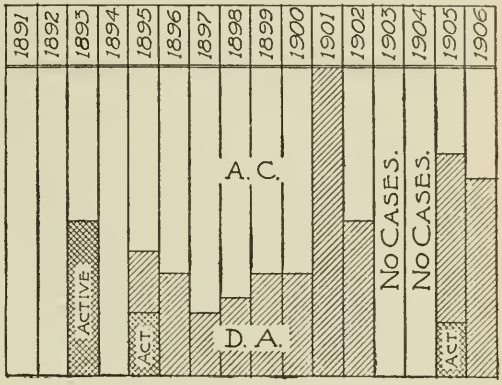


FIG. 148.—CONDITIONS ON DISCHARGE, EXPRESSED PROPORTIONALLY, OF PATIENTS IN THE INCIPIENT STAGE, TREATED WITH TUBERCULIN, DISCHARGED EACH YEAR. A. C. apparently cured, D. A. disease arrested, Act., active. (Adirondack Cottage Sanatorium.)

While prognosis in any individual patient is most uncertain, the results in a large number of selected patients can be said to be practically always favorable. Selection of patients may, therefore, have some, and in reality has had, a large part in the favorable results obtained with tuberculin. The scientific spirit seems sadly lacking in many observers who have reported on patients treated by this method.

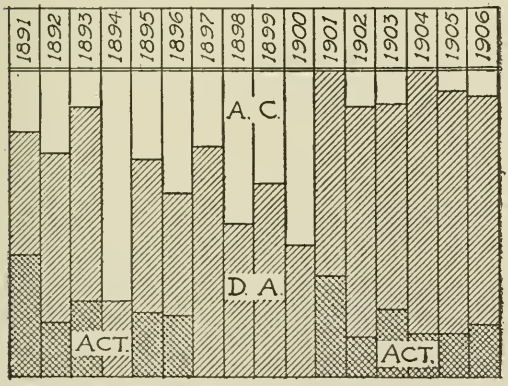


FIG. 149.—CONDITIONS ON DISCHARGE, EXPRESSED PROPORTIONALLY, OF PATIENTS IN THE MODERATELY ADVANCED STAGE, TREATED WITH TUBERCULIN, DISCHARGED EACH YEAR. (Adirondack Cottage Sanatorium.)

It appears that many believe that a statement of the number of patients and of how many were "cured," "arrested," and "failed" was sufficient. A grave error may underlie such figures. In one instance the patients may all be in such an early stage that an astonishingly large percentage must be apparently cured, while in another the patients may be so severely affected that improvement of any sort is almost impossible. When this error is avoided, the patients are often classified by some method peculiar to the observer. Notwithstanding this, many writers on the tuberculin

treatment have grouped all these patients together and hoped thus to get an idea of the results of tuberculin treatment. Such methods easily lead to false conclusions.

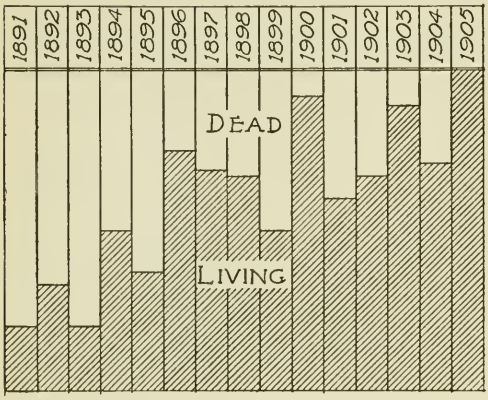


Fig. 150.—Proportions of Dead and Living in 1906 of All Those Treated with Tuberculin in Each Year. (Adirondack Cottage Sanatorium.)

When patients are carefully classified on admission, the divisions of the classification may be so broad that such selection can be exercised as to interfere gravely with any comparison. Since 1890 Trudeau has continuously used various forms of tuberculin at the Adirondack Cottage Sanatorium in spite of the fact that strong pressure was brought to bear on him to discontinue their use. The patients subjected to this treatment were carefully selected, and until 1902 only those in good general condition and without fever or

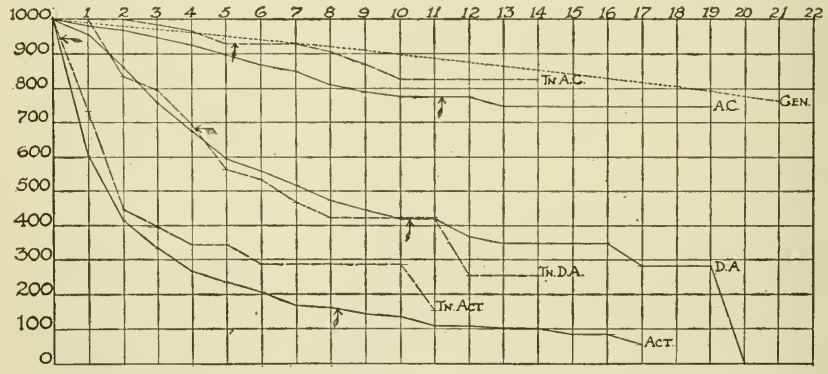


Fig. 151.—Showing the Numbers per Thousand Surviving at the End of 1, 2, 3, etc., Years After Leaving the Adirondack Cottage Sanatorium, of Those Who were Discharged Apparently Cured, with Disease Arrested, and Active. The solid lines represent the total, and the broken lines those treated with tuberculin. The dotted line shows the expected survivors according to general mortality table. (Farr, No. 3.)

serious complication were given tuberculin treatment. It was given in 1890 and 1891 to a few patients in far advanced stages as a last resort.

Since 1902 any patients who wished tuberculin received it, as it was hoped in this way to avoid selection, but such has not been the case. Inasmuch as patients who received tuberculin have been permitted to remain longer, those who for any reason—e. g., tubercle bacilli still present in the sputum, improvement not sufficiently rapid, the presence of extensive lesions, etc.—desired to remain longer, elected to take tuberculin. Consequently, while from 1897 to 1900 a large number of incipient cases received tuberculin, from 1903 on the majority have been moderately advanced cases. This latter stage is the broadest in the classification used and admits of far wider variation than the incipient. Koch's original tuberculin, his bacillary emulsion, Trudeau's modification B, Denys's bouillon filtrate and tuberculo-plasmin, have been chiefly used, but tuberculin R and tuberculol have been given to a few patients.

While the number of patients treated with tuberculin at the Adirondack Cottage Sanatorium has not been large, the care with which the patients have been followed render the following results of interest. To allow of comparison, since the numbers in each group varied so much from year to year, it is necessary to reduce or to increase the numbers of the treated and untreated in each class in each year to 100. This gives the following tables, expressed in percentages, in which are included the results on discharge and the ultimate results of 185 patients treated with and 864 treated without tuberculin who remained in the institution over ninety days and had tubercle bacilli in their sputum:

Results on Discharge

	With Tuberculin.	Without Tuberculin.
Incipient:		
Apparently cured	56	50
Disease arrested	34	38
Active	10	11
Moderately advanced:		
Apparently cured	27	6
Disease arrested	55	51
Active	18	43

The ultimate results, expressed in percentages of those living one to fifteen years after discharge, proper allowance being made for the varying numbers in each year and class, are as follows:

Ultimate Results

	With Tuberculin.	Without Tuberculin.
Incipient:		
Apparently cured	88	78
Disease arrested	77	78
Active	33	27
Moderately advanced:		
Apparently cured	91	86
Disease arrested	48	45
Active	41	22

These statistics indicate that on discharge the incipient cases have done somewhat better than those receiving no tuberculin, while the moderately advanced cases showed much better results. The ultimate results do not show such marked differences, but indicate that the treated, both incipient and moderately advanced, do better.

Reports of Tuberculin Treatment.—A review of the literature shows that the lack of proper, or indeed of any, classification of patients renders many results of small value for comparison—e. g., those of Amrein, Aufrecht, Beck, Elsaesser, A. Fraenkel, Heron, Holdheim, Kaatzer, Krause, Kreuser, Schroeder, and many others. Guttstadt ('91), who edited the first large collection of reports on the tuberculin test and treatment (1891), reported figures during the era of "tuberculin delirium" and overdosage. He found only twenty per cent of "cures," but all stages were treated, and his figures have little bearing on tuberculin treatment as at present administered.

Denison ('02) has reported 213 patients treated with various culture products and serums. His best results were obtained with von Ruck's watery extract. Of 33 patients so treated, of whom definite information was given, 28 were alive and 5 dead one and two third years after treatment.

Denys ('05) reports 442 patients treated with bouillon filtrate (B. F.). He uses a personal classification both on admission and discharge and compares the results obtained with those secured in 39 non-injected patients (Stage I, Turban, afebrile), of whom 4 were healed, 24 died, 9 failed, and 2 remained stationary. Of the 442 patients treated, 193 (44 per cent) were healed, 56 (13 per cent) arrested, 65 (15 per cent) improved, 28 (6 per cent) stationary and failed, and 100 (23 per cent) died. The striking feature of these statistics is the fact that all the "controls" died. Febrile patients were not excluded from those treated (see Schnoeller).

The results of Goetsch ('01) have been much quoted and received on

their publication the indorsement of Koch. He treated with Koch's O. T. 224 patients, chiefly in the incipient stage (88 only had tubercle bacilli in the sputum, 135 reacted to tuberculin, and 1 had tubercle bacilli in the glands). Of these, 12 were too short a time under treatment and in too advanced a stage to obtain any results of value, 37 patients had just started the treatment, and 50 were treated too short a time. These were excluded and the remainder (125), all in the incipient stage, were cured.

Guttmann and Ehrlich ('91) the first to advocate small doses, gave old tuberculin to 18 men and 18 women, all afebrile, 13 in the incipient and 23 in the moderately advanced stage. They reported all "practically improved." Inasmuch as only a small percentage of such patients fail to *improve* under suitable conditions without tuberculin, these figures are of small value.

E. Klebs ('03–4) uses a personal classification and obtains results varying from 100 per cent of cures in his first stage through 90 per cent, 57 per cent down to 5.5 per cent of recoveries for his last stage (fourth). In his second stage all improved, in the third 97 per cent, in the fourth 33.5 per cent.

The results of Langenbach and Wolff ('91) were based on a comparison of 99 patients treated with original tuberculin and 99 untreated, all in as nearly as possible the same condition (many far advanced). After a careful study the authors conclude that those treated with tuberculin were on an average in slightly more advanced stages at the beginning of treatment. Of the treated patients 33 were healed and 21 died; of the untreated 9 were healed and 45 died. Some of the patients treated with tuberculin were also given sodium picrate and sublimate (corrosive?), and these the authors think did best. These drugs alone were of no value.

Ludke ('07) reported of 100 patients treated with old tuberculin (Turban II, 64, III, 36) 62 improved and 11 died.

Mitelescu classified 30 patients, 22 with closed and 8 with open pulmonary tuberculosis. Of the former, 20 were healed, 2 improved; of the latter, 5 were healed and 2 improved.

The largest statistics so far published of value for comparison, are those of Moeller ('03–4) at Belzig. Only afebrile patients, with not too far advanced laryngeal and pulmonary disease, without heart or kidney disease, were given tuberculin. Reduced to a percentage basis the tabular comparison is as follows:

Stage Turban	No.		Healed (Per cent)		Arrested (Per cent)		Improved (Per cent)		Unimproved or Failed (Per cent)	
	Tr.	Untr.	Tr.	Untr.	Tr.	Untr.	Tr.	Untr.	Tr.	Untr.
I.....	134	281	51	32	37	51	10	16	1	1
II.....	105	290	18	3	44	27	32	59	6	11
III.....	90	362	0	0	41	6	36	31	23	63
Total....	329	933	27	10	40	26	24	35	9	28

Attention is here directed to the marked advantage in favor of the patients treated in Stage II. Stage I is much wider than Trudeau's incipient class and shows correspondingly a greater advantage in favor of the treated. In these stages careful selection may account in large part for the differences obtained. In a study of the tuberculin-treated patients at Belzig, Loewenstein and Rappoport state that they consider only those patients who received at least 10 mgm. of old tuberculin. By this selection all highly susceptible individuals are excluded. If this susceptibility is an indication of lack of resistance another process of selection is exercised. This does not hold for the foregoing figures.

Petruschky divides his patients treated with tuberculin into open (38) and closed (54) pulmonary tuberculosis. In the latter all were healed, in the former 15 were healed and 23 are dead.

The results reported by Nagel ('06) from Cottbus are apparently in favor of the patients treated with tuberculin. Here the results obtained in Stage I (Turban) closely approximate the results in the incipient stage at the Adirondack Cottage Sanitarium—i. e., little difference exists in the immediate result between the treated and untreated patients. In Stage II, however, the healed are three times as numerous among the treated as among the untreated, and those able to work fully two thirds as many more among the treated as among the untreated patients. Stage III shows similar results. Tuberculin has, however, been administered at Cottbus only for three years (1902–4). The improvement in sanatorium results during recent years, due no doubt to the earlier diagnoses, is very marked. The comparison given, therefore, is between selected patients of later years and those not chosen for tuberculin. These latter are probably better than the tuberculin treated, and certainly no worse as a whole. Comparison of these (598) with the patients treated with tuberculin (184) (obtained by subtracting table of all patients treated with tuberculin from table of all pa-

tients during years in which tuberculin was used) gives very interesting results, shown in the following table in percentages:

No. of Patients		Stage Turban	Healed and Able to Work		Partially Able to Work		Unable to Work, Worse	
Tr.	Untr.		Tr.	Untr.	Tr.	Untr.	Tr.	Untr.
32	521	I	87	92	13	8	0	0.2
116	65	II	70	71	23	20	7	9.0
36	12	III	14	0	56	58	30	42.0

These figures show very little difference between the treated and untreated patients, and would suggest that either tuberculin has exerted no effect upon the immediate results or that the patients subjected to the tuberculin treatment were worse, which Nagel states to be the case. Patients with more advanced disease were chosen for tuberculin treatment, and often only those not doing well under hygienic-dietetic treatment, especially in open pulmonary tuberculosis of the earlier stages.

Recently Bandelier and Roepke ('08) have published results obtained at Cottbus by the use of B. E. and Perlsucht O. T. The following table gives these results as compared with the nontreated cases referred to above:

Stage	Results	Nontreated Patients, 1902–4	Patients Treated with B. E.	Patients Treated with Perlsucht O. T.
I	Healed	212—41%	10—37%	11—34%
	Able to work	265—51%	12—44%	19—59%
	Partly able to work	43— 8%	5—19%	2— 6%
	Unable to work	1— 0%	0— 0%	0— 0%
II	Healed	5— 8%	13—10%	25—21%
	Able to work	41—63%	77—62%	66—56%
	Partly able to work	13—20%	30—24%	26—22%
	Unable to work	6— 9%	4— 3%	0— 0%
III	Healed	0— 0%	0— 0%	0— 0%
	Able to work	0— 0%	9—17%	9—31%
	Partly able to work	7—58%	35—65%	16—55%
	Unable to work	5—42%	10—19%	4—14%

For some years von Ruck has reported no patients who have not received treatment with his watery extract, and his figures therefore afford no basis for comparison of treated and untreated patients. His use of a personal classification also renders comparison of his results with those of others difficult or impossible. He has obtained, he states, excellent results.

Schmoeller ('05) has reported 211 patients treated with Denys's tuberculin. Of these in Stage I (Turban) (25) 100 per cent improved, 68 per cent were healed; of Stage II (121), 94 per cent improved, 25 per cent were healed; of Stage III (65), 72 per cent improved, 3 per cent were healed.

Carl Spengler, by the aid of bovine tuberculin, obtains 100 per cent of cures in Stages I and II (Turban) and 99.7 per cent of cures in the same stages with tuberculin from bovine and human strains. Such figures need no comment.

Turban's ('06) results are based on the treatment of 327 patients, 241 without and 86 with tuberculin. All had tubercle bacilli in their sputum. "Lasting healing" was obtained in 53 per cent of the latter and in 39 per cent of the former.

The ultimate results of tuberculin treatment are believed by some to be the real test of the value of this treatment. The ultimate results obtained by Trudeau have been mentioned. Heron treated 32 (unclassified) patients with tuberculin, and seven years later found 10 well, 1 relapsed, 8 dead, and 13 untraced. Holdheim in 15 unclassified ambulant patients similarly treated obtained after two years a negative tuberculin test and observed no recurrence of symptoms. During the winter of 1890–91 Rembold treated 82 patients with old tuberculin. Six years later he traced 70 patients, 27 of whom had had mixed infections and had died (23 in the first year, 2 in the second, and 2 in the third year after treatment). Of the remainder (43) 18 were dead, 12 improved, and 13 cured. Of the 13 cured 12 had early and 10 closed pulmonary tuberculosis. Three of the 12 patients improved had closed lesions.

Loss of Tubercle Bacilli.—The loss of tubercle bacilli in the sputum by patients undergoing treatment is evidently of the greatest importance, and since it has been roughly estimated that only 42 per cent of patients lose their bacilli during residence in a sanatorium, it is clear that any treatment that will increase these figures is of great importance, even if it accomplished little else. Patients treated with tuberculin usually remain longer in sanatoriums, a fact that directly influences the disappearance of tubercle bacilli from the sputum. A study at the Adirondack Cottage Sanitarium of the cases previously mentioned showed that in the incipient class 64 per cent of those treated without and 67 per cent of those treated with tuberculin lost their bacilli, while for the moderately advanced the figures were 24 and 44. Bandelier and Roepke ('08) have recently published their results obtained with B. E. and bovine old tuberculin, which are as follows:

Percentages of Patients who Lost Tubercle Bacilli

Stage	B. E	Bovine O. T.
I	100	100
II	78	90
III	34	39

Kreuser selected 110 patients with tubercle bacilli in their sputum and treated 55 without and 55 with tuberculin. Of the latter, 22 lost their bacilli, of the former 16. Philippi ('06) compared 98 patients without tuberculin treatment with 28 so treated (all afebrile), and found in the second stage (Turban) 19 per cent of the untreated and 58 per cent of the treated lost the tubercle bacilli from their sputum, while of the third stage 7 per cent of the untreated and 31 per cent of the treated lost their bacilli. Turban found at the end of from two to six years that 48 per cent of the treated and 27 per cent of the untreated had sputum free from tubercle bacilli.

The present status of tuberculin may be expressed in a few words. Tuberculin when properly given does no harm, may produce no apparent result, and may markedly benefit an individual patient, who can follow at the same time the hygienic-dietetic treatment while in a health resort, at home and at rest, or at work. Small doses and careful increase are most important, and by following them very closely some patients, even in advanced stages, reap great benefit. The immediate and ultimate results are improved, fewer relapses occur, and more patients lose the tubercle bacilli in their sputum.

ANTAGONISTIC BACTERIA

(*Bacterio-therapy*)

Bacterium Termo.—Cantani ('85) advocated spraying into the lungs a culture of *bacterium termo*, which Ravenel states has been found to be a mixture of a number of putrefactive organisms. This treatment was based upon the theory that putrefactive organisms destroyed tubercle bacilli, a view that De Toma ('90) clearly disproved. It is useless to review the work on this subject, a task already performed by De Toma ('88–'90) and Moeller ('04).

Erysipelas.—Solles ('90) thought that erysipelas prolonged the life of tuberculous guinea pigs, a statement that has aroused little interest.

Syphilis.—Portucalis is stated by Braunstein and Fraenkel ('01) to have inoculated patients with lues to cure tuberculosis. There is

no record to show that his temerity has been equaled, and proof exists to show that syphilis is a predisposing factor to tuberculosis.

Yeast.—Tournier ('00) stated that yeast had some healing influence on tuberculosis, and Huggard and Morland ('05) have since recommended it on account of its rich content of nucleic acid. (See Koumiss.)

Merrihy ('97) used *Bacillus coli communis* with good results, and Moeller ('04) sarcina and cocci without results and *Bacillus tumescus* and *Bacillus mesentericus* with slightly favorable results. Maher ('06) urged the use of a bacillus found in milk and elsewhere, which he called *Bacillus X*. His results have not been confirmed. There is at hand some evidence to show that patients contracting typhoid fever do remarkably well, but no one to the writer's knowledge has as yet suggested the use of these organisms for the cure of tuberculosis.

"Acid-fast" Bacteria.—Moeller ('04), the authority on this class of organisms, asserts that a close relationship exists between them and the tubercle bacillus, and that immunization against the one may protect, in part, at least, against the other. The agglutination test does not differentiate them (Koch), and Klemperer and Moeller found that the timothy-hay bacilli offered some protection to experimental animals. Moeller found that the more virulent members of the group afforded the better protection against tubercle bacilli, but that avirulent individuals of one species protected against the virulent members of the same species, and homologous bacteria were not necessary to produce marked immunity against these acid-fast bacteria.

Attenuated Tubercle Bacilli.—The best immunity to tuberculosis has, as Trudeau ('06 B) has shown, been obtained by living tubercle bacilli, attenuated to a marked degree, but not completely avirulent for guinea pigs. These small animals have not yet been fully immunized against tuberculosis, and the results in rabbits on account of the pronounced natural immunity are often unsatisfying. The human strain of tubercle bacilli have been attenuated by many means (heat, sunlight, decomposition, long growth, unfavorable media, passage through refractory animals, treatment with glycerin, phenol, and various antiseptics, soaking in serums and in emulsions of lymph glands), and the tubercle bacilli then used for immunizing purposes. Dixon ('89) first obtained a rather high degree of immunity to tuberculosis in experimental animals by preliminary inoculation of attenuated tubercle bacilli (Pearson, '06). Trudeau ('93) was able to show marked improvement in rabbits' eyes by the use of living avian tubercle bacilli.

De Schweinitz ('94) reported marked immunity in a cow inoculated with an organism attenuated by growth (Trudeau's R bacillus), but the work of McFadyean ('01), who used avian tubercle bacilli intra-

venously, was the first to attract widespread attention. In December, 1901, von Behring announced that he was trying to immunize cattle by repeated intravenous inoculation of attenuated human tubercle bacilli, but Pearson and Gilliland were the first to bring forward proof substantiating such a claim. Later von Behring ('05) has put upon the market his "bovo-vaccine," a powder of dried human tubercle bacilli which keeps but one month. "Tauruman" of Koch ('00) and Schütz is a similar product, but retains its virulence longer. Both are used intravenously. Since then Neufeld, von Behring, Hutyra, and others have shown that cattle can be immunized against a dose of tubercle bacilli given experimentally and acquired naturally in infected stables, which is fatal for controls. Only young animals which are not to be milked or used for food for many months are suitable for vaccination. Calmette and Guerin ('07) have obtained some immunity in calves by feeding them dead tubercle bacilli.

Vaccination.—Marfan ('86) noted that patients, once fully cured of a local tuberculosis, rarely suffered again from tuberculosis. Koch ('90) had noted a difference in local reaction in tuberculous and healthy guinea pigs to the injection of tubercle bacilli. Maragliano ('04) more recently has attempted to produce a focus of tuberculous inflammation in the skin without the use of living tubercle bacilli. Accordingly, he has inoculated individuals in the arm in three places about one and a half inches apart with 1 mgm. of dried tubercle bacilli heated to 150° C. in glycerin for one and a half hours. A small pustule with a larger area of induration accompanied with some fever for two days occurs. This is repeated once and no reaction follows. The value of this has naturally not been proved on man, but animals resist afterwards virulent tubercle bacilli.

Other strains of tubercle bacilli have been used for immunity. Avian tubercle bacilli were first used by Trudeau, Héricourt ('92), and Paterson, while Friedmann ('03) has urged the use of his turtle tubercle bacillus, which was later proved virulent for warm-blooded animals. Küster ('06) employed a frog tubercle bacillus, Moeller ('04) on himself a tubercle bacillus passed through the blind-worm, while Klemperer ('05) inoculated himself and five patients with living bovine tubercle bacilli. Spengler ('04) has done the same thing, using 0.5 mgm. of living bovine tubercle bacilli and experienced only ulceration at the site of inoculation. These attempts have not been followed up, as they proved little.

Products of the Tubercle Bacillus.—Since 1890 great attention has been given to the use of the various products of the tubercle bacillus, and more recently dead tubercle bacilli have been largely employed. Trudeau's ('06) experiments have conclusively shown that attenuated

tubercle bacilli give the best protection; then come in order dead tubercle bacilli and the various products of tubercle bacilli known as tuberculins, which have been discussed at length.

ORGANOTHERAPY

The treatment of pulmonary tuberculosis by extracts of various tissues, healthy and tuberculous, has been often attempted. The tissues most frequently employed have been the lymphatic glands, the muscles, the lungs, and the blood cells.

Lungs.—As early as the seventeenth century (1638) Robert Fludd, an English physician, advocated the injection of sputum for the cure of pulmonary tuberculosis. Cavagnis ('86) obtained with tuberculous sputum, treated with phenol, favorable results in pulmonary tuberculosis. Krause ('06) injected subcutaneously into one patient his own sterilized tuberculous sputum with only slight rise of temperature and without local reaction, and obtained pronounced decrease of catarrh and marked improvement of the general health.

Allen ('07) advocated the use of specially homogenized and sterilized (by repeated heating to 60° C.) tuberculous sputum in pulmonary tuberculosis more on account, it is true, of the homologous uncultivated bacteria. Loewenstein ('06) found that leucocytes obtained from the urine of a patient with tuberculous cystitis phagocyted heterologous but not homologous tubercle bacilli, until treated with B. E. (heterologous). Wright ('07), who is strongly in favor of homologous bacterial vaccines, makes little or no mention of it in tuberculosis and, in all the vaccines employed, cultivation of the organisms seems in no way to decrease their effect.

As late as 1897 and 1898, Lemery and Schroeder advocated the use of the lungs of the fox, one cooked, the other as a powder. Some years ago two homeopathic physicians, Jaeger and Burnett ('00), advocated the use of powdered tuberculous pulmonary tissue in the treatment of tuberculosis, and this substance in its various "potencies" is to be found to-day in the homeopathic pharmacopœia. Allen ('07 B), Saranac Lake, was unable to discover any tubercle bacilli or their fragments in the sugar-coated pills. More recently Peter Paterson ('06) has used the caseous material from tuberculous foci. Basing his work upon a theory that because tubercle bacilli do not grow in pus in abscesses while they grow in the wall there is some antagonistic substance in the caseous matter, he has sterilized this by alternate freezing and thawing for six months. It is then thoroughly washed to remove all soluble toxins, and an emulsion (1 c.c. = 0.005 gm.) made in salt solution. Large doses only cause febrile reaction. The best dose is 0.1 c.c. to 0.5 c.c., which

should cause a rise of 0.5° F. Five patients have done well under this treatment.

A criticism of all such attempts with tuberculous tissue may readily be made, in that all these tissues contain tubercle bacilli and it is a fair induction that any benefit arising from such powders or emulsions may be due to the tubercle bacilli or its toxins which they contain.

The juices or extracts of normal lungs have also been tried. Brunet has found that guinea pigs inoculated with glycerin or aqueous extracts of pulmonary tissue lived a little longer than the controls, and that four patients, while experiencing some oppression and congestion (of the lung?), had less expectoration and were somewhat improved. Grande has used a pulmonary extract and also 4 to 5 gm. a day of powdered lung tissue in the form of pills, and one patient so treated improved.

Lymphatic Glands.—(*a*) *Tuberculous.*—Rodet ('03) macerated in sterile water tuberculous glands from guinea pigs, added thymol and allowed the suspension to stand until the tubercle bacilli were dead. The results in guinea pigs were unfavorable in regard to treatment, but seemed to increase in a certain measure the resistance to infection. Large doses were employed.

Rimbaud ('04) used practically the same method of preparation, but, on account of induration at the site of injection, he later filtered the emulsion through paper. Human tuberculous glands (excised at operation), as well as tuberculous glands from guinea pigs, were employed. His results were similar to those of Rodet.

Baldwin and Price obtained negative results in guinea pigs from an emulsion of a tuberculous gland removed during the height of a tuberculin reaction from a calf, previously inoculated with virulent human tubercle bacilli. McCullough, who has had good results in treating glandular tuberculosis with X-rays, attributes it to a setting free of vaccine, encapsulated in the gland, "in consequence of the resorbent action of the X-rays on the rudimentary neoplastic tissue that encapsulates the tuberculous gland." This auto-inoculation with homologous bacteria raises the opsonic index.

(*b*) *Normal.*—The lymphatic glands are said to contain much nucleic acid, which has been shown to stimulate the formation of leucocytes. Arguing from this and from the fact that thyroid extract is, when administered by mouth, just as efficacious as when injected subcutaneously, Hoffman had administered powdered bronchial glands dried *in vacuo* at a low temperature. His claims for this powder are absurdly extravagant. Several authorities have found that tubercle bacilli subjected to the influence of material obtained from lymphoid organs for twenty-two days were greatly attenuated (Brieger, Kitasato,

and Wassermann, quoted by Bartel ('06) and Neumann), and Bartel believes that tubercle bacilli so treated will prove an effectual vaccine material. Baldwin has found that opsonized tubercle bacilli are more quickly fatal for guinea pigs.

Muscle.—The muscle plasma, ordinarily termed fresh beef juice, has come into much prominence since the publications of Richet ('00) and Héricourt ('00). They obtained striking results in the treatment of inoculated dogs, many making good recoveries. Fraenkel and Sobernheim ('01), and again Brown ('03), were unable to substantiate these claims.

In patients with pulmonary tuberculosis many have obtained good results, but the majority of observers attribute these favorable results to its action as a suraliment. Some (Balladere), however, still attribute to the muscle plasma an action, bactericidal and antitoxic for the tubercle bacilli, while others suggest the use of the meat of immunized cattle (Maragliano).

Blood Cells.—Lumière, and later Gélibert, have used by intramuscular injection the plasmic contents of the blood cells "of a certain number of animals," calling the extract hemoplase or plasmo-therapy. In 112 patients treated with this substance Gélibert found that only 9 failed to improve. Baldwin and Price obtained in guinea pigs negative results from an extract of the leucocytes of an immunized cow. Daremberg, following Pasteur's work in rabies, injected without results an emulsion of the spinal cord of tuberculous guinea pigs and rabbits into guinea pigs and rabbits. An emulsion of marrow from a calf produced no apparent results when injected into guinea pigs (Baldwin and Price).

Rimbaud ('04) has made some experiments on passive organotherapy, using the serum of a goat inoculated with the tuberculous glands of a guinea pig or man. The results were negative. Haentjens ('06) has used two dogs and tuberculous sputum in the same way, and obtained, he claims, good results in patients with the serum. Matsutow believes that tuberculin is not the toxin of the tubercle bacillus produced in the living organism. This real toxin, free from tubercle bacilli, he claims to have obtained in extracts of tuberculous organs of guinea pigs, and with it has so immunized guinea pigs that they resisted a fully virulent culture. The organs of the goat and dog have also been used, but with little effect. Fauvel uses subcutaneously in animals extracts of the nasal and pharyngeal mucous membranes in Hayem's artificial serum with benefit. This preparation, which he called paratoxin T., gave good results in sixty-two patients.

Organotherapy, active or passive, in pulmonary tuberculosis, rests today upon little sound favorable evidence, and occupies in the specific

therapy of pulmonary tuberculosis a position demanding on its practical side little or no consideration.

HEMOTHERAPY

Hemotherapy, first employed by Fiedler ('70), using defibrinated blood of immune animals, and later by Héricourt and Richet ('88–'90), has chiefly an historical interest, since Bouchard, Buchner and others showed that the serum contains practically all the immunizing elements of the entire blood. The first investigators, basing their experiments upon the fact that dogs are refractory to tuberculosis, injected dogs' blood into the peritoneal cavity of rabbits and rendered them more refractory to tuberculosis. Bernheim, having found the goat very refractory to tuberculosis, used intravenous injections of goats' blood in 13 patients. Of 11 in the "first and second" stages, 7 were cured, 4 greatly improved, while 2 in the "third" stage died, 1 from syncope during the transfusion. Bertin and Picq injected goats' blood in the subcutaneous and muscular tissue of the buttock in 150 patients with good results, save in a few who overexercised and developed abscesses and urticaria.

Figari has obtained increased antitoxic and antibacillary substances in the serum of 18 patients (5 cured, 13 greatly improved), who were given pulverized blood clots to which had been added glycerin and aromatics. Similar results were obtained with guinea pigs. The immunizing substance is in the hemoglobin, Figari holds. Ricci obtained poor results in three cases, but upholds the views of Figari. Niccolini, who similarly prepared and administered blood clots from immunized calves, observed in patients increased weight and increased agglutinating power of the serum. He gave 7 patients Maragliano's hemoantitoxin in doses of 15 c.c. or less, according to age, and obtained healing in 4, improvement in 2, while 1 died. Hemoplase, the plasmatic content of hemoglobin, gave good results according to Lumière, quoted by Gélibert.

Since the work of Bouchard, which showed that all the immunizing properties of the blood are contained in the serum, little interest has been taken in hemotherapy, and in the light of our present knowledge of agglutinins and precipitins the blood should not be used for immunizing purposes.

SEROTHERAPY

Passive immunization by means of serums of treated animals has been attempted by many, more especially since Behring's and Roux's successful work in diphtheria. The first work was naturally with the

serums of animals immune to tuberculosis, which Bouchard ('92) by experiments on guinea pigs showed of little value. This again turned attention to organotherapy, which in turn was supplanted by the use of serums of artificially immunized animals. The first work along these lines was that by Auclair ('96), who immunized fowls to human tubercle bacilli, but obtained no antitoxic serum. Following this, many attempts have been made to obtain such a serum, but to-day, while several men claim to have such a serum, they have so far been unable to establish their claim.

The amount of work and literature upon this subject is overwhelming, and can only be touched on summarily.

Among the animals used for the production of an immune serum are fowls, the horse, mule, ass, goat, dog, sheep, and cattle (milk). These animals have been inoculated with many products mentioned under hemotherapy and organotherapy, with tubercle bacilli, virulent and attenuated by many means (long growth, passage through refractory animals, glycerin, heat, decomposition, sputum treated with phenol, etc.), of all strains, human, bovine, avian, and cold-blooded; with many varieties of tuberculin (O. T., T. R., B. E., Béraneck's, etc.); with acid-resisting bacilli (timothy hay).

Varieties.—The immunizing serums in use at present have dwindled down to very few. Those most used are Marmorek's ('03, '04, '05) and Maragliano's, but de Schweinitz, Fisch, Paquin, Arloing, Baumgarten, von Behring, have also worked on serums. Monard, Blache, and others have prepared and used artificial serums; others have combined iodoform and guaiacol with serums. The serum of the normal horse and the diphtheria-antitoxic serum have been advocated. The milk of immunized animals (cows chiefly) has also been employed.

Administration.—The method of administration was at first entirely subcutaneous, but more recently serums have been extensively used *per rectum* (Chantemesse, '96), and many given *per os*. Maragliano and several of his pupils claim to have given intrapulmonary injections with benefit. Large quantities of serum (one eighth of the body weight of a rabbit) can be administered to some animals without any apparent injury (Heilner). The use of serums by mouth, especially in the case of milk of immunized cows, has led to much work. It may now be stated that only during the first two or three weeks of life can antitoxic serums be absorbed by intact mucous membranes, and Salge, quoted by Hamburger ('05), has shown that diphtheria antitoxin is not absorbed from milk by infants, which leads Hamburger to doubt if foreign albumins in cows' milk are ever absorbed. It is possible, but not probable, that antituberculosis serums may act differently from others. Jemma has found that infants acquire no increased agglutination after using im-

mune milk unless the parents be tuberculous. Maragliano and Figari deny these assertions.

Results.—The results of passive immunization are neither brilliant nor promising. The injection of a serum produces a ferment in the blood, not usually present, and dependent only upon the presence of the peculiar proteid injected (Heilner). Many of the serums advocated for use in man rest upon little or no experimental basis, and this, coupled with the facts that normal serum of one species of animal may stimulate slightly the blood-forming organs of another and so increase resistance to infection (Weigert), and that suggestion cannot be eliminated, throws much doubt upon the results of many observers. Trudeau and Baldwin, Arloing, Mafucci and Di Vestea, Sokolowski, Karwacki ('05), and others have either obtained no proof of antitoxic substances or no beneficial clinical results.

Serum Disease.—The "serum disease" (v. Pirquet and Schick ('05)) manifested in man by urticaria, arthralgia, and fever, occurs usually ten to twelve days after the injection of a serum. The "Theobald Smith" phenomenon, anaphylaxis to serum, described by Rosenau and Anderson ('08) in America and Otto ('04) in Germany, occurring violently and fatally in guinea pigs if an interval of eight to thirteen days be suffered to elapse between the first and second injections, rarely occurs severely in man, and needs little consideration in most patients. Calcium salts, as Wright ('96) suggested, lessen the symptoms in man. The injection of any serum into the veins causes severe collapse and cyanosis, and every care should be taken to avoid this, for at least one fatal case has occurred.

Maragliano's Serum.—Maragliano in 1895 first began to publish his results with his antituberculosis serum, and from that time to 1900 he wrote twenty-three articles, and others brought up the list to one hundred and eighty-two papers on this serum.

In immunizing animals (usually the horse, cow, or calf), Maragliano used subcutaneously increasing quantities of (1) his watery extract and the filtrate through porcelain of virulent, living cultures, together with the (2) bacillary pulp, a filtrate through porcelain of tubercle bacilli ground in sand and water. Equal quantities of these two substances are injected simultaneously in different parts of the body. If borne without marked fever or local reaction, a second injection of double the amount is made after three days. The dose is steadily increased until the serum of the animal has a high agglutination and protective power—i. e., until the serum is of such a power that $\frac{1}{1000}$ c.c. will protect 1 gm. guinea pig. The test poison is the watery tuberculin, which is so concentrated that doses of one per cent of body weight will kill a guinea pig not sooner than twenty-four hours nor later than five days.

The administration of the serum has been chiefly subcutaneous, 1 c.c. every second day for ten days, then 5 c.c. every second day for ten days, next 10 c.c. every second day for twenty days more. More recently Maragliano has advocated its use by mouth, Livierato has injected it into the lung, and Hegar has painted it upon exposed tuberculous areas —all, they claim, with good results.

Any case, Maragliano says, is suitable for treatment, and many good results are obtained in patients who continue to work and follow few hygienic rules.

The serum, according to Maragliano, is both antitoxic and bactericidal; it reduces fever, lessens the "number of tubercle bacilli," increases the weight and abates symptoms. Hegar believes it acts only on the toxins. Karwacki ('05), who experimented with the serum, came to the following conclusions: Maragliano's serum is more poisonous to guinea pigs than normal horse serum. The serum contains no antiprotein, and does not protect the guinea pig from a lethal dose of tuberculin, but rather it hastens death through acute intoxication. The serum has no higher agglutinating properties than normal horse serum. The serum contains specific amboceptors, and in the animal organism gives rise to bacteriolysis of the tubercle bacilli. The serum when injected together with tubercle bacilli protects from anatomical tuberculosis, but not from protein intoxication. The serum has an unfavorable action on tuberculosis in process of evolution.

The results obtained by Maragliano ('05) and his *confrères*, from 1895 to 1905, in 1,164 patients may be grouped as follows:

	Total.	Healed.	Per Cent.
Destructive lesion with cavity	162	3	2
Destructive lesion without cavity	164	17	10
Diffuse lesion with fever	206	19	9
Diffuse lesion without fever	191	26	14
Limited lesion with fever	191	68	56
Limited lesion without fever	250	45	58

These results are good, but are no better than many obtain without specific treatment. In this country, Ravenel, Walsh, Landis, and Stanton, at the Phipps Institute, obtained no definitely beneficial results. Ravenel, who has worked with Maragliano, is convinced that this serum will protect animals from fatal doses of tubercle bacilli, but is not so sure of its curative properties.

Marmorek's Serum.—Marmorek in 1903 resigned from the Pasteur Institute to present to the French Academy of Medicine his discoveries in regard to the antituberculosis serum now bearing his name. He stated that tuberculin was not the true toxin of tuberculosis; that young

(*primitif*) tubercle bacilli excreted no tuberculin, but a different toxin; that by the use of a medium consisting of a mixture of leucocytic serum (from a calf injected with guinea-pig's leucocytes) and of glycerinated liver bouillon he could obtain these young forms in sufficient quantities to immunize a horse whose serum was strongly antitoxic. The serum was first advised to be used subcutaneously, but later has been given per rectum, in doses of 5 or 10 c.c. every day for three weeks, omitted for two weeks and then repeated. A cleansing enema should be first given.

The results are very difficult to determine. Monod ('07), who is in favor of it, has reviewed the literature up to 1907, and states that thirty-eight out of forty-three papers were in favor of it. Closer analysis than this cannot be made of these results, and the fact that other workers (Roux, Borrel) at the Pasteur Institute were unable to confirm his fundamental experiments has thrown grave doubt upon this serum. According to some observers, normal horse or any foreign serum has a stimulating effect upon patients (Weigert), and this with suggestion may in part at least account for the results. As is usual with all remedies, the symptoms and signs are said to decrease markedly under Marmorek's serum, but Levin has found that in guinea pigs it retards the growth of the tubercle bacilli and neutralizes the poison. Notwithstanding the numerous "testimonials" from many sources, this and all other serums for use in tuberculosis must still be considered in the experimental stage.

Tyndale ('90) suggested the use of pure vaccine lymph, and a few used it, but without avail.

The serous exudate from blisters has been used by Margant, and the injection of a small quantity of pleural-serous effusions under the skin is said to hasten their absorption. Flick and others advocate the production of blisters in order to allow absorption of the contents, and thus to inoculate the patient with an homologous serum.

Antistreptococcic Serum.—The use of antistreptococcus serums (Marmorek, Aronsohn, Menzer, etc.) have been much vaunted by some observers as exerting a "specific" action upon phthisis, which, they say, is due to a secondary infection with streptococci and other organisms. The results are not promising, and the premises not always sound. "Mixed infection" has been made the scapegoat, as Sahli says, for many failures in tuberculin and other treatments of tuberculosis.

"FALSE SPECIFICS"

The history of the use and advocacy of "specifics" in the treatment of tuberculosis long antedates the discovery of the tubercle bacillus, and, in fact, takes us back to the time when the memory of man runneth

not to the contrary. Indeed, in the history of no disease are there recorded more "specifics," advocated in many instances by men of high reputations, who were misled by their own enthusiasm and by the unconsciously imparted suggestion to the patients. In less enthusiastic hands the period of infatuation following the announcement of some new drug of great potency is shortly followed by disenchantment, disuse, or even oblivion, justly merited in many instances. These substances have been well named "false specifics."

The "antiseptic treatment" of pulmonary tuberculosis, based on the idea that it is possible to destroy the tubercle bacillus *in situ* without harming the tissues, needs only to be mentioned to be dismissed. Furthermore, many of the tubercle bacilli, embedded in thick fibrous tissue or even caseous matter, have little or no direct communication with the air (inhalation), or with the blood or lymph current. The view that healthy contiguous parts may be protected in this way has never been proved by clinical experience, either in pulmonary or localized surgical forms of tuberculosis. No medicinal substance has been found to neutralize the tuberculous toxin.

Many drugs have been given empirically (iodin, mercury, arsenic, antimony, etc.), but, since the discovery of the tubercle bacillus, experimental research has been frequently employed in studying their effects. Neither guinea pigs nor rabbits are altogether suitable for such work; the former are too greatly, the latter too slightly, susceptible to tuberculosis. The older work, based entirely upon the effect of substances upon the tubercle bacillus *in vitro*, has been largely abandoned, and inhalations and injections of many antiseptic substances are now recognized, as far as they exert any action upon the pulmonary tuberculosis, as of no specific value.

Creosote and its Derivatives.—Among the most used of all the false specifics in pulmonary tuberculosis stand these drugs. They have never been proved to exert any action whatsoever upon the tuberculous process, but in some patients have almost a specific action upon the accompanying secondary infections of the lungs, such as simple bronchitis. They also exert a very stimulating effect upon the bronchial mucous membranes during their excretion through it. For this effect small doses only are necessary in most patients (for example, 3 or 5 ♏ of beechwood creosote, or creosotal, three times a day for some weeks, etc.) and Sommerbrodt's dictum that the larger the daily dose the better the results can now be refuted. One gram (15 gr.) of creosote (1 to 4,000 in the circulating blood) at least is necessary, judging from experiments *in vitro*, to exert any influence upon the tubercle bacillus, and to maintain it at this level would require many times the dose that injures most patients. When the tissue fluid and lymph

are taken into consideration, the absurdity of such attempts becomes apparent.

It has long been known that the combination of small doses of creosote with cod-liver oil often render the oil more easily digested, which is due, no doubt, to the stimulating effect of the small quantity of creosote (drop doses) on a poorly secreting stomach. The substances have been said, but not proved, to increase the agglutinating power of the blood serum, to favor phagocytosis, and to act upon the tubercle toxins.

Guaiacol, more toxic than creosote, has been used for the reduction of fever (painting the skin with 1 gm. or less of pure guaiacol, or of 1 c.c. of a twenty-five-per-cent solution in alcohol), or for analgesia in complicating neuritis or intercostal neuralgia. In larger doses, repeated daily, it may produce collapse, and cannot be recommended. Like creosote it has been administered by inunction, by injection (subcutaneous, intratracheal, intrapulmonary, and *per rectum*), or, preferably, *per os* in capsules. Gluten-coated pills, insoluble in the stomach, or gelatin globules or capsules, are the best way in which to administer creosote. Flick advised rather large doses in water one hour before meals. The contraindications include, among others, fever, persistent tachycardia, and hemoptysis, but a persistent taste of creosote, gastric irritation, and nephritis are of more importance. The patient should always be warned to stop it or any medicine if the slightest digestive disturbances occur. Only pure beechwood creosote should be used, but several instances of poisoning from the usual doses have been recorded.

The derivatives of creosote are increasing daily, and the following list includes only some of the more important: Creosotal (creosote carbonate, 92 per cent creosote), less irritating than creosote, 5 or more drops in capsules, etc., p. c.; duotal (guaiacol carbonate, 90 per cent guaiacol), 5 to 15 gr. (0.3 to 1.0 gm.) in capsules p. c.; thiocol (potassium guaiacol sulphonate, 60 per cent guaiacol), a nonirritating, nontoxic, odorless, tasteless powder, soluble in water; sirolin, 10 per cent thiocol in orange sirup, 5 to 10 gr. or more (0.3 to 0.6 gm.) p. c.

Gomenol (Dubousquet and Laborderie, '05), distilled from selected leaves of *melaleuca verdiflora*, and consisting in large part of a terebene, eucalyptol, citrene, and terpincol, is nontoxic, can be used subcutaneously or *per os*, and has much the same effect as creosote, but is less irritant.

Arsenic and its Derivatives.—Arsenic has been held by some to act as a specific in pulmonary tuberculosis, and in this, as in some other chronic nervous and wasting diseases, it stimulates nutrition remarkably. It has long been used in anemic patients successfully, but in fever the results are questionable. It may be given as sodium or strychnin

arsenate (gr. $\frac{1}{16}$ to $\frac{1}{8}$), or as Fowler's solution (gtt. ij, or more p. c.). The latter has been combined with a tincture of iron or iron arsenate (gr. $\frac{1}{16}$ to $\frac{1}{8}$, 0.004 to 0.008 gm.), and has been administered alone in anemic patients with good results. The cacodylates (sodium, strychnin, guaiacol, iron), first advocated by Gautier, and containing 54 per cent of arsenic, can be given in large doses hypodermically (up to 4 cg. (6 gr.) p. d.), but are very little absorbed (Fraser), and in some patients produce disagreeable symptoms, such as garlicky odor of the breath, exfoliative dermatitis, etc. A useful formula for subcutaneous injection is:

℞ Morphinæ hydrochloratis	gr. ss.;	.03 gm.
Cocainæ hydrochloratis	" jss.;	0.1 "
Sodii chloridi	" iij;	0.2 "
Sodium cacodylatis	" xxv;	1.5 "
Phenol	gtt. ij;	gtt. ij
Aqua destil. q.s.ad.	℥iijss.;	104 gm.

The beginning dose is usually 0.5 c.c. ($7\frac{1}{2}$ ♏) twice a day for six days, then thrice a day for three to five days. After an omission of several days the treatment is again begun. The results are not highly satisfactory, though it may be tried if arsenic, when found to be beneficial, cannot be taken continuously by mouth. Disorders of the liver and continued gastric or intestinal disturbances are contraindications to arsenic in any form. It has been advised to administer arsenic only in early or quiescent stages. Histogenol (sodium methylarsenate and nucleic acid), arrhenal (monomethyl arsenate, atoxyl, and vanadium) have been used.

Alcohol.—Alcohol, formerly considered a specific in pulmonary tuberculosis, has a slight food value (as a tissue sparer); it may, when properly given, stimulate the appetite and lessen the cough, but exerts no action upon the disease itself. Harris, who gave twenty-six patients $1\frac{1}{2}$ oz. alcohol every four hours, night and day, for some time, saw no extension of the disease. Mircoli, confirmed by Gervino, asserted that in moderate quantities it neutralizes the tuberculous toxin, and so helps pulmonary tuberculosis. Meltzer holds alcohol to be of benefit in acute infections, producing by its vasoconstricting action upon the splanchnic area a redistribution of the blood. Many have thought that, as alcohol produced cirrhosis of the liver and of the kidney, it would also produce it in the lung, but no good evidence of this has been adduced.

The advocates of alcohol in pulmonary tuberculosis have, however, always based their claim for it on its symptomatic effect. Brehmer based his warm support of alcohol on its power, as he had observed it, to increase the appetite and to lower the fever. Other observers claim it increases the gastric secretion, enables more fatty food to be taken and

assimilated, stimulates the heart and central nervous system, preventing hypochondria, relieves night sweats and insomnia, and in some cases lessens coughing. The modern tendency is to reduce greatly the dose earlier advocated by Brehmer, Dettweiler, Flint, etc.

The objections to its use are numerous, and more patients with pulmonary tuberculosis have been harmed than helped by alcohol. It is nothing short of criminal to send a young man away from home with his trunk full of whisky bottles, and tell him to drink all he can. The enforced idleness, the *bonne camaraderie*, prove too much for many who have been warned against it, and great care should be exercised about sending patients to a hotel for a long residence. Not only the men have to be considered, but, unfortunately, some classes of women are not wholly exempt from this danger, and Oliver has noted alcoholic neuritis most frequent in pulmonary tuberculosis. When a patient once begins to drink at a health resort, his only salvation lies in turning his back upon his boon companions and seeking health elsewhere.

Alcohol should not be used for some time after hemoptysis, and especial care should be taken when it is used in cold climates and high elevations, though in the Alps it is widely used without any apparent deleterious effect. Nervous, excitable patients should avoid it, and individuals long accustomed to its use in large quantities should reduce this amount to a minimum. When this is not possible, it should be proscribed, as is also the case when it increases cough or irritates the larynx or stomach.

In brief, alcohol may be said to be a dangerous food and a "symptomatic" drug of considerable potential danger, but of value in some cases of pulmonary tuberculosis. A cocktail, tablespoonful of whisky, a glass of stout, of bitter ale, or of a good wine, taken before, or, better, with the first part of the meal, may aid a flagging appetite or a weak digestion. It must be remembered, however, that these are to be looked upon as drugs, and taken only when necessary. When it is impossible for a patient to take milk without a small amount of brandy or whisky, or eggs without sherry, these should be allowed. Insomnia may be relieved by a glass of beer or ale or a little whisky at bedtime, but these are dangerous remedies. Brandy and champagne are of value in some cases late in the disease. The judicious though rather free use of spirits does unquestionably prolong the existence of a few patients with slowly progressing chronic disease.

Alcohol, on the whole, is not necessary in the treatment of pulmonary tuberculosis, as in nearly every instance the same effect can be produced more surely, even if less pleasantly, by some other drug.

Drugs that Produce Leucocytosis.—Recent work upon the importance of leucocytosis in tuberculosis has brought again to attention a number

of substances which cause leucocytosis. The effects of tuberculin are discussed in another place. The most important of these substances are nuclein and cinnamic acids.

Nucleic Acid.—Nucleic acid, which is contained in tuberculin, is probably the best example of this class of drugs. Its use in the form of yeast, which is rich in nuclein, has recently been advocated by Ullmann, Huggard, and Morland ('05). Long an old-fashioned household remedy for boils, it has recently been said to be of value in pulmonary tuberculosis, where it increases the leucocytes and the opsonic index when administered by mouth in doses of 3 to 10 grams (50 to 150 grains) of dried yeast in milk twice a day. Brewer's yeast may be used. It exerts apparently no effect upon the temperature, the kidneys, or intercurrent affections.

Cinnamic Acid.—Cinnamic acid and its sodium salt, hetol, first advocated by Landerer ('98–'01), has been used chiefly in Germany. When properly administered, hetol is said to produce leucocytosis and an increase of connective tissue about the tuberculous focus. Others have claimed that it prevents or replaces caseous matter by vascular connective tissue, forming true cicatrices, increases the lymph flow, the alexines, and thus produces healing of the tuberculous lesion. Balsam of Peru, first employed by Sayre, of New York, led Landerer to the use of hetol. It has been administered by ingestion, by inhalation, by subcutaneous injection, but preferably by intravenous or intramuscular (intragluteal) injection. At first a dose of 0.05 to 0.1 c.c. (♏ 1½) of a 1-per-cent solution of hetol (½ to 1 mgm.) in 0.75 per cent NaCl solution is injected into the brachial vein twice or thrice a week, and slowly increased up to 8 to 15 mgm. (⅛ to ¼ gr.) for men, and 5 to 10 mgm. (1/12 to ⅙ gr.) for women, which dose is usually reached in three to five weeks. The "normal" dose is that which produces no untoward symptoms, but improvement of general and local symptoms. The rules for increasing the doses demand the same careful clinical observation and caution detailed for tuberculin. The treatment is continued for three months in early, six months in advanced, stages. After an interval of four to eight weeks, a second course of one to two months is advised if tubercle bacilli are still present. The treatment should be continued four weeks after the disappearance of tubercle bacilli.

The results of this treatment are, in the hands of most observers, favorable. Cantorowitz and R. Weissmann, in Schmidt's "Jahrbücher" ('01 and '04), have collected 140 papers on the subject, a large majority being favorable. Among 28 papers by different observers, 4 noted improvement in the tuberculous condition, 9 in the symptoms, 7 were doubtful as to the results, and 8 were unfavorable (Brown). The same division of opinion exists in regard to experimental tuberculosis (in rab-

bits and guinea pigs). Repeated injection into the same vein is not harmful, and the kidneys are not affected, but chronic albuminuria and diabetes are contraindications. Evidently much in regard to results depends upon the selection of early stages for treatment, and patients with fever, hemoptysis, and night sweats are not deemed suitable. Ambulatory patients and those discharged "prematurely" from sanatoriums give good results, and, according to Landerer, need no change of residence. Landerer obtained, in patients with uncomplicated pulmonary tuberculosis, healing in 85 per cent and improvement in 5 per cent. In all classes of patients he obtained 70 per cent of "good results."

For febrile patients he advises colloid silver, and for patients with cavitation thoracoplasty. Calcium chloride and sodium silicate, in hope of their deposition in the scar tissue, have been injudiciously advised. The so-called "Hoff's cure," consisting of cinnamic acid, arsenic, and alcohol, is administered *per os*, and is now little used, either by the laity or by the profession. Loew advocated theoretically sodium phenylpropylic acid, as it contained less hydrogen, and was, therefore, more "strongly bactericidal." Bulling has used it as a spray, and obtained good results.

Ichthyol.—Ichthyol, first used in pulmonary tuberculosis by M. Cohn ('96), is held to possess a nonirritating, nonpoisonous, alterative action (checking albuminous decomposition), as well as tonic and vasoconstricting properties. It is said to increase the appetite, to loosen and reduce the expectoration, to bronze the skin in some patients (10 per cent), and to be valuable in all patients through its vasoconstricting, decongesting action on the lungs. A few observers have obtained good results. The ammonium sulphoichthyolate, in doses of 2 to 50 drops in water, capsules or pills, and ichthoform (ichthyol and formalin), in doses of gr. $1\frac{1}{2}$ to 5 (0.05 to 0.3 gm.) five or six times a day; ichthalbin, 10 to 15 gr. (0.6 to 1 gm.) p. c., a tasteless powder, consisting of ichthyol and albumin, are usually given for some months. Ichthyol contains much sulphur, and has such a disagreeable taste and odor that it is little used. "Resorption pills" (ichthyol and salicylic acid) have been tried (Rohden). Sulphur has for many centuries been used as an inhalation.

Iodin.—The antiseptic action of iodin on the tubercle bacillus is slight (0.5-per-cent solution, after exposure of one hour, prevents growth, Kinneman). It is said to excite phagocytosis. Potassium iodid (gr. 5 to 10), hydriodic acid, and iodopin may aid the cough, but the chief value at present of iodin in pulmonary tuberculosis is as a rubefacient in pleurisy. Iodin may be painted on (tincture, colorless), or rubbed into the skin (iodin petrogen, 10 per cent, europhon in olive oil, etc.). Iodoform, without action in pulmonary tuberculosis, has been used intravenously (Dewar). Many combinations of iodin and iodo-

form have been employed (eigon, iodolen, iodal, aristol, nosophen, antinosin, eudoxin, losophan, europhen, loretin, vioform) for one purpose or another in tuberculous patients. Cantacuzene ('05) has recently found that defatted tubercle bacilli treated with iodin (Lugol's solution) are absorbed much more readily, and apparently give better immunity to the animals experimented on, than tubercle bacilli not treated with iodin. He has also found that the administration of potassium iodid favors the absorption of these bacilli and of tuberculous deposits.

Silver.—The chief benefit now attributed to the use of silver is its effect upon the secondary organisms in the lungs. In the form of collargol it has been given *per os*, *per rectum*, and intravenously. The results have not been very satisfactory. Mays ('00), who asserts that pulmonary tuberculosis is fundamentally a nervous disease, injects nitrate of silver under the skin of the neck over the vagus. Protargol and lysargin have been used.

Lecithin.—Tuberculous guinea pigs are said to live longer when given lecithin (Claude, '01), which in man is asserted to be harmless, to decrease phosphorus output, to increase nitrogen absorption, weight, strength, and acidity of the urine, and to be of marked value in nervous conditions. It can be obtained in pills or powder (dose 0.25 to 0.50 gm., 3 to 7½ gr., per day), or be given subcutaneously in oil (dose 0.05 to 0.15 every two days, or smaller doses more often. In nervous complications (neurasthenia, etc.) it may be tried. Biosin, an albumin-iron-lecithin combination, and glidin have been used.

Calcium.—Various salts of calcium, carbonate, bicarbonate, phosphate, iodid, given by mouth or hypodermically, alone or in combination with creosote, tuberculin, etc., are of value on account of the demineralization occurring in pulmonary tuberculosis, but exert no specific action. They are said to be deposited in the foci of inflammation, and so afford a mechanical stimulus which starts and aids the process of repair (Michelaozzi, '04).

Cellotropin (Kopp, '04), a monobenzoylarbutin, a white, odorless, slightly bitter, crystalline powder, easily soluble in alcohol, with difficulty in water, has been suggested by Kopp, for he believes, after absorption unchanged into the blood, it stimulates the glands to increased enzyme formation, and thus forms "under the influence of the bacillus alexines." The substance, in doses of 15 gr. (1 gm.) three to five times a day, produces no gastric disturbances, and is suitable in not too far advanced stages, where it exerts a specific action. Further confirmation of the few published results are needed before it can be recommended.

Harper ('01), basing his theory upon the antagonism of gout and tuberculosis, advocated the use of urea (synthetic) in doses of 15 gr.

(1 gm.) *pro die,* increased in some cases to 60 gr. (4 gm.) as a maximum. Many observers have used it without any beneficial effect. The Calcutta Zoological Garden receives three hundred dollars annually from the natives for the urine of the rhinocerus, which is taken for lung disease.

Griserin (Küster, '04), first presented to the profession under the name of "loretin" as a substitute for iodoform, is of no value and of some danger in pulmonary tuberculosis.

Basing his views on the results of Bier's treatment in tuberculous joints, as well as upon the "immunity" in heart disease, pregnancy, and gibbus, H. Weber ('08) attempts to explain the value of the prone position and the sanatorium treatment in pulmonary tuberculosis by the increased amount of CO_2 in the lungs and body, and claims to have had excellent results in this disease by the use of sodium bicarbonate (4 gm. a. c.) or levulose (50 to 100 gm. daily for a month) *per os,* or the subcutaneous injection of liquid paraffin (antiphthisin).

Strychnin.—Strychnin (gr. $\frac{1}{30}$, 0.002 gm.) is of value. It acts advantageously upon the lowered blood tension, a weakened heart, a jaded appetite, and upon the neurasthenia, but is no "specific."

Inhalations.—No substance has yet been found (nor will there be) that acts only on the diseased part of the lung even were it able to penetrate to the often impermeable or closed focus of disease. Inhalations have been used in the treatment of pulmonary tuberculosis since remote antiquity. The substances used have differed as widely as the effluvia of cow stables and aromatic oils on one hand, and chloroform and hydrofluoric acid on the other. These substances have been in the form of gas, spray, fluid, and powder, varying from the most innocuous to irritant, irrespirable substances (bromin, iodin, and chlorin). The object aimed at in most cases has been a direct action upon the tubercle bacillus. The nose, tongue, pharynx (at right angles to the entering vapor or spray), the larynx, and the innumerable branchings of the bronchi, all offer in some instances (powders, coarse sprays) insuperable obstacles. The secretions upon the surface of the air passages may be coagulated by, or may absorb, the inhalant. Notwithstanding all this, however, there finally remains the fact that the diseased areas are often impermeable, and if permeable the lesion may still be closed. Furthermore, the failure of sprays to affect diphtheria or lupus, both so situated that they are ready of access, is well known. From these facts, it is readily seen that no "specific" introduced by inhalation, and acting directly upon the focus of disease, can be hoped for.

The hemoglobin absorbs all the oxygen it can hold in combination from the air, and superoxygenated gases increase only the oxygen in

the serum ($\frac{1}{15}$ to $\frac{1}{10}$). Oxygen in itself has no specific effect. Ozone is an indicator of pure fresh air, and many have transferred the effect of the latter to the former, which in reality is an irritant to the respiratory membranes, and more injurious if absorbed. Any gas poor in oxygen causes reflexly deeper respiration, and consequently an increased blood flow, which may result in loosening, and even in lessening, the sputum in some cases. This, no doubt, is the explanation of the results when any are obtained from the use of nitrogen, carbon dioxide, and sulphuretted hydrogen as inhalations. Inhalations of hydrocyanic acid, chlorin, bromin, iodin, hydrofluoric acid, sulphuric acid, osmic acid, nitrous oxide, benzene, anilin, belladonna, and hemlock leaves have yielded no help, and possibly in some cases done harm.

Inhalations of formaldehyde and its derivatives (igazol, menthobromo-formol, etc.) alone or in combination with sulphurous ether, chloroform, menthol, etc., may exert some influence upon secondary infection, but can also cause pulmonary edema if too strong. Creosote and the ethereal oils have been much vaunted.

From the fact that workers in and dwellers about cellulose factories seldom contract pulmonary tuberculosis, and do well when this occurs, Hartmann ('92) was led to suggest the inhalation of ligno-sulphite, produced by the action of sulphuric acid upon the ethereal oil of fir, juniper, or eucalyptus. It seems to attack the mucin, and so loosens the expectoration. It is now little used. Similar arguments have been advanced for sulphurous-acid inhalation.

Sanosin (Danelius and Sommerbrod), a mixture of charcoal, sulphur, and leaves of a variety of the eucalyptus, for inhalation after vaporization, is of no value.

Sprays.—A number of substances previously mentioned have been used in this manner. The inhalation of spray containing yeast has been suggested. The same objections hold for sprays as for inhalations, but many "specifics" have been so administered.

Injections.—Inasmuch as a large number of substances have been injected in one way or another into the body, usually in the vain hope of finding a specific similar to mercury for lues, or quinin for malaria and further, as most of these do not merit a separate notice, it has been deemed wise to collect many of them under this head. The number of substances, soluble and insoluble, that have been injected into the body is extraordinary; the fertility of imagination exercised in their selection and the lack of ingenuity in controlling the results is astounding. These substances have been injected *per rectum*, subcutaneously, intravenously, intratracheally, and into the pulmonary tissue.

A partial list is appended (the substances in italics may be of some value, the remainder cannot be recommended):

Per Rectum: *Cod-liver oil*, creosote, *arsenious acid*, H_2S and CO_2, etc.

Subcutaneously: Cod-liver oil (glycerin extract, olive oil, *camphorated oil* (in late stages), vaselin, creosote, guaiacol (simple, cacodylate, iodoformized), eucalyptol, arsenious acid, *arseniate of strychnin*, of soda, *sodium cacodylate*, phosphate of lime (to replace excess lost), green ammonio citrate of iron, kalodal (soluble albuminate of silver, for nourishment), $AgNO_3$ (over vagus), phenol, salol, aristol, ether and opium, iodin with potassium iodid, etc.; chloride of gold, antiphthisicum (liquid paraffin), gomenol, globulin, yeast.

Intravenously: *Hetol*, formaldehyde, iodoform, creosote, etc.

Intratracheal: *Creosote*, guaiacol, *menthol, camphor*, chlorotone, iodoform, potassium permanganate, izal, eucalyptol, gomenol, gobional, silver nitrate in *olive oil*, glycerin or water, through *larynx* or through skin, etc.; orthoform.

Intrapulmonary: Zinc chlorid, phenol, naphthol, iodoform, creosote, thymol, iodoformized glycerin.

The intravenous injection of formaldehyde (50 c.c. of a 0.5-per-cent solution in physiologic saline solution), advocated by Maguire, has been little used, and cannot be recommended.

Intratracheal injection, first used by Green of New York ('55), has not been very extensively employed.

Jacob's method of pulmonary infusion of tuberculin and creosote in large quantities has met with severe and just criticism on account of its danger. Among the many substances suggested, the most widely used are menthol, camphor, creosote, and guaiacol, alone or in combination in one-to-four-per-cent solution in olive oil. The chief, if not the only, value of intratracheal injections is to control the cough.

ADDENDA

Summary of Specific Treatment Presented at the International Congress, Held in Washington, D. C.

Tuberculinum purum is a form of toxin prepared by Gabrilowitsch from cultures of tubercle bacilli (human strain), and so altered by chemical reagents that it no longer produces any general reaction. The initial dose is 0.01 mgm., the final dose from 100 to 200 mgm. In 80 per cent of 25 patients (8 with severe type of the disease, and only 3 with a mild type) the number of injections was twenty, extending over forty to sixty days. The results claimed by Gabrilowitsch are excellent, but verification in the hands of others has not yet been made public, and the results are almost too favorable, though details about the class

of patients have not yet been published. All patients, the author thinks, may derive benefit from this tuberculin.

Calmette described a new form of tuberculin, C. L., obtained by centrifuging *in vacuo* at a low temperature entire cultures of bovine bacilli. The product is then filtered, precipitated three times with alcohol and ether, redissolved in water, and dialyzed until all the salts and precipitants have been completely eliminated. The colloid substances in the dialyzer are precipitated once more by alcohol and ether, and dried *in vacuo*. The active substance is not heated, and subjected to no treatment except precipitation by alcohol and ether. By von Lingelsheim's method it was found ten times as toxic for guinea pigs as O. T., but could be introduced intravenously into the body of an animal in large doses without producing any elevation of temperature. The beginning dose is 0.001 mgm., which should be slowly increased at intervals of ten to twelve days in order to avoid a reaction of more than 0.5° C. This tuberculin, Calmette believes, does not cure tuberculosis any more than any other form of tuberculin, but delays the progress of the disease and endows the organism with resistance to infection, which he and Guerin have proved on cattle. They, however, do not acquire a true immunity, and, although they do not react to tuberculin, they are nevertheless carriers of tubercle bacilli, and capable of contracting a chronic form of tuberculosis. Such results lead them to oppose the use of living tubercle bacilli in man, especially as tuberculin is equally efficient and less dangerous.

Calmette also stated that tuberculin possesses an affinity for lipoids (probably identical with lecithin), which are almost constantly present in the serum of tuberculous men and cattle. Arguing from the fact that cobravenin is rendered active by the free lecithin of serum, he believes that tuberculin is indicated for determining the affinity of the patient's serum for the secretory products of the tubercle bacillus. Its systematic employment enables the clinician to observe accurately the effects of tuberculin medication.

Trudeau discussed the laboratory (antibacterial) and the clinical (antitoxic) method of the administration of tuberculin, and stated that the latter was the better method. He held that the dose should be slowly increased, and that he now thought the size of the final dose was a matter of less importance than formerly. The final dose may be only a fraction of a milligram.

Denys reaffirmed his absolute confidence in his broth filtrate, B. F., or F. B., as he calls it in English. He advocates beginning with very small doses, e. g., in afrebile patients with 0.000,000,05 to 0.000,000,1 c.c., while in even slightly febrile patients he advocates 0.000,000,000,5 to 0.000,000,001 c.c. He knows no contraindications to its use, and at-

tributes its failure in acute pulmonary tuberculosis to lack of time before death ensues. His enthusiasm is unbounded.

Hammer stated that, while tuberculin would not cure the most advanced stages of pulmonary tuberculosis, it eliminated many disagreeable symptoms. In patients whose physical signs were in Stage I or II, or at times even in III (Turban), recovery is to be expected.

Petruschky reaffirmed his belief in tuberculin, both for treatment and diagnosis, and held that patients with closed lesions should be treated to prevent ulceration into the bronchus and the recurrence of tubercle bacilli in the sputum.

Meissen still holds that tuberculin has not been proved to have a specific curative action, and, if used, should be given only in hospitals or institutions.

The work of Kinghorn, Twichell, Carter, and Werry, who followed the tuberculo-opsonic index of patients who were given O. T. and B. E. by the clinical method with progressing doses, showed that after inoculation this index was raised, that positive and negative phases do occur; that, when tuberculin is given at intervals of three or four days, 25 per cent received the injections during a negative phase; that in 85 per cent of these, the negative phase was not accentuated, but that a positive phase at once set in. Notwithstanding the fact that they believe that this index is of doubtful value in controlling tuberculin injections on phthisical patients, and that the aim of tuberculin treatment should be to produce tuberculin immunization, rather than to keep the opsonic index at a high level—notwithstanding these facts, they think the interval between doses should be increased to seven days, to allow the disturbance in the blood to subside. If an abolition of the negative phase be desirable, then this work proves that intervals of three or four days are advisable for most patients.

Hastings, who has done much work with the opsonic index, announced that the variations "are so wide without inoculation, and so inconstant after inoculation, that one cannot safely use the index as a guide for tuberculin inoculations."

The very ingenious work of Webb, Williams, and Barber in attempting immunization by the injection of increasing numbers of living organisms, beginning with one, is striking and original. The technic of Barber employed, consists of selecting under the microscope from a hanging drop of emulsion the exact number of bacilli by means of a capillary pipette. Such work, however, has to do chiefly with the production of immunity in healthy animals, for many experimenters (Trudeau, Calmette, Courmont, and Lesieur) have found that injection of living tubercle bacilli influenced a previous tuberculosis little, if at all. The work of these latter observers is certainly open to the objection that

they used too large doses, a point which Webb and his *confrères* are now endeavoring to prove. They have, from their reports, conferred upon mice immunity to anthrax, and certainly upon guinea pigs some immunity to tuberculosis. The use of living tubercle bacilli in man is not justifiable in the light of our present knowledge.

The work of J. Courmont and Lesieur throws some doubt upon the immunity conferred upon animals (cattle, etc.) by some vaccinations, for they find that a lesion in process of evolution prevents the evolution of a second inoculation, while the first runs its normal course. An attenuated tubercle bacillus, however, or a strain little virulent for a species of animal may in this way protect against a second virulent inoculation.

Flick reported the work on Maragliano's serum at the Phipps Institute. Twenty members of the staff used this serum, which was prepared by Ravenel according to Maragliano's methods. It was found to have no specific value, and both cows which furnished the serum were discovered to be tuberculous, one dying from generalized tuberculosis.

The untoward effects of Maragliano's serum were studied in forty-one patients by Landis, who found evidence of marked hypersusceptibility (suffused face, dyspnea, oppression about the heart, rapid pulse, lumbar pain, muscular tremors, sense of impending death, but no fatalities) in seventeen per cent, who were in a moderately or far advanced stage, and confined to bed. There was no definite time for the occurrence of these symptoms. Ambulant patients in good condition did not develop anaphylaxis.

CHAPTER II

SPECIFIC THERAPEUTICS OF MIXED AND CONCOMITANT INFECTIONS

By GERALD B. WEBB

A NATURAL outcome of Wright's exploitation of bacterial vaccines is the application of their use to the concomitant or mixed infections of pulmonary and other forms of tuberculosis. To attempt the cure of cases complicated by secondary infections by means of tuberculin alone, trusting that the organism will rid itself of these secondary invaders, is hardly rational.

While the suggestion that mixed infections must be expected in the common suppurative processes which occur in connection with surfaces which harbor microbes may well be universally acceptable as not breaking in on any accepted ideas, the suggestion that mixed infection must perforce be considered in every case of phthisis, lupus, tubercular caries, tubercular cystitis, and tubercular ulceration, in the very nature of things, will be unacceptable to many clinicians. Such a suggestion will be felt to throw doubt not only on the clearness of vision of those who have sought for antituberculous remedies in these diseases, but also on the critical acumen of those who, without taking into account the fallacies which are incidental to clinical methods, have confidently undertaken to pass final judgment on antituberculous remedies by the observation of their clinical effects in cases in which, in addition to the tubercle bacillus, other pathogenetic microbes may have been at work.

Be it acceptable or unacceptable, there is no escape from the fact that practically every case of suppurating lupus is complicated by staphylococcus infection, and every aggravated case of lupus with a streptococcus infection. What holds true of lupus, *mutatis mutandis*, is true of every tuberculous affection to which microbes can find access (A. E. Wright, '07).

At present there is the greatest divergence of opinion as to the influence of secondary organisms on the course of pulmonary tuberculosis. It is, perhaps, a fact that many of these secondary organisms are of low vitality and nonvirulent, but it is just as impossible for such patients to rid themselves of these as of local infections, such as acne, furuncu-

losis, both such frequent afflictions of the tuberculous. Surgeons familiar with bone tuberculosis know how well patients with pure tuberculous disease improve, and yet how intractable are those cases with mixed infection.

The results of Prudden's ('94) well-known experiments on rabbits show conclusively that the concurrent action of two distinct pathogenic germs may result in a considerable modification of the lesions which either could produce alone.

It has been well said by a Frenchman that "the worst thing that can happen to a tuberculous person is to come in contact with a consumptive," a remark which I would extend to the greater danger the tuberculous invalid runs when exposed to an influenza epidemic.

The suggestion has been made that the influenza organism is probably the means of introducing the pneumococcus into the system of the victim of pulmonary tuberculosis, and it is perhaps true, yet my own observations would seem to show that the influenza bacillus alone is capable of much mischief in the tuberculous invalid.

At the time of writing, forty-five patients, undergoing inoculations with tuberculin and mixed vaccines, have been exposed to a very widespread epidemic of a catarrhal condition due chiefly to the influenza bacillus, in part to the *Micrococcus catarrhalis*. Of these forty-five patients, five have the influenza bacillus persistently in the sputa, and they have been inoculated periodically with their influenza vaccines. These have escaped "colds."

The results are only suggestive. They may be tabulated as follows—forty-five patients, exposed to a widespread influenza epidemic, receiving inoculations of tuberculin and mixed vaccines every seven to ten days:

Inoculated against influenza with their own vaccines	5		Escaped epidemic.
Inoculated against influenza with stock vaccines	8	All gave accurate histories of repeated former attacks.	Escaped epidemic.
Preventive inoculation not given; patients denying that they ever had influenza	32		Fifteen succumbed to influenza epidemic.

Fifteen of these patients, who at the outbreak of the epidemic claimed never to have had the grip—neither had the influenza bacillus hitherto been found—succumbed, and the influenza bacillus was then found in their sputa. Two of these patients, for the first time, developed very serious hemorrhages within a few days of the infection.

Eight patients who claimed to have had influenza frequently (one every year for eight years) were given from 125,000,000 to 500,000,000 of influenza vaccine at each weekly inoculation. These patients were well exposed to the epidemic, and without exception everyone escaped infection.

The writer has observed a patient's opsonic index to tubercle lowered to 0.6 during an influenza attack. It is a common observation that patients with pulmonary tuberculosis may go rapidly down hill following an attack of influenza, and the writer would suggest that the prevention of such concomitant infection should be sought by the means indicated above. The vaccine used in these cases was prepared according to Wright's methods from a case of acute infection of a maxillary sinus occurring in a patient who had suffered a similar attack for four or more successive years. Heretofore a period of chronicity had followed annually, necessitating a specialist's attention for a period of months. This year, however, rapid healing followed the use of the vaccine.

The frequency of occurrence of the secondary invaders is listed variously by different investigators. From an unpublished report from Dr. T. W. Hastings, of the Cornell University Medical College, it is learned that in 375 cases of nontuberculous pulmonary conditions (tuberculosis suspected, but tubercle bacilli not found), the frequency of occurrence of secondary organisms was as follows:

Micrococcus catarrhalis.
Pneumococcus (Fraenkel).
Streptococcus pyogenes.
Staphylococcus pyogenes (aureus, albus, or citreus).
Friedländer's bacillus (Bacillus mucosus capsulatus).
Micrococcus tetragenus.
Bacillus influenza.
Bacillus subtilis.
Bacillus pyocyaneus.

Cultures were taken in only 105 of these cases, and the same order of frequency held, except that staphylococci were first instead of fourth.

Of 156 cases of pulmonary tuberculosis (tubercle bacilli detected in sputum), cultures were taken in only 20 cases. The order of occurrence of secondary organisms was as follows:

Streptococcus pyogenes.
Micrococcus catarrhalis.
Pneumococcus (Fraenkel).
Staphylococcus (aureus, albus, or citreus).
Bacillus pyocyaneus.
Friedländer's bacillus (Bacillus mucosus capsulatus).
Micrococcus tetragenus.

Reference to the work of Ravenel and Irwin ('07) shows results of examination of all the organs in 56 cases that came to the postmortem table:

Bacillus coli communis	in	40 cases.
Streptococcus	"	39 "
Staphylococcus pyogenes albus	"	30 "
Staphylococcus pyogenes aureus	"	26 "
Pneumococcus	"	9 "
Bacillus diphtheriæ (pseudo)	"	11 "

Pyocyaneus, sarcinæ, etc.

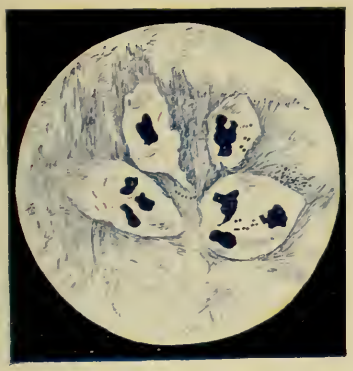
Examination of the tables shows that our results agree in the main with those of other observers. The streptococcus, often in chains or pairs, was most frequently found, not only in cavities, but also in the organs. The notable exceptions to this were the kidneys, in which the bacillus coli communis was found nineteen times and the streptococcus ten times and the liver, in which the bacillus coli communis was found twelve times, and the streptococcus only twice. The frequency with which the kidney was infected is worthy of comment—twenty-nine times in the fifty-six autopsies—leading the liver in this respect. It is, of course, impossible to say in what proportion of cases the bacillary invasion was agonal, or postmortem, but, in any event, the liver would seem to be more open to such invasion than the kidneys.

LUNG CAVITIES

Number of cases examined, 50; microörganisms being found in all.	Streptococcus.	37 cases.
	Staphylococcus pyogenes albus.	25 "
	Staphylococcus pyogenes aureus	24 "
	Pneumococcus.	8 "
	Bacillus pyocyaneus.	2 "
	Bacillus coli communis.	37 "
	Bacillus lactis acrogenes.	3 "
	Bacillus diphtheriæ (pseudo).	9 "
	Sarcinæ.	10 "
	Yeasts.	12 "
	Spirillum.	1 case.
	Small diplococcus (unidentified).	2 cases.
	Bacillus (unidentified).	6 "

AREAS OF BRONCHOPNEUMONIA

Number of cases examined, 5; microörganisms found in 3.	Streptococcus.	1 case.
	Staphylococcus pyogenes albus.	1 "
	Staphylococcus pyogenes aureus	2 cases.
	Pneumococcus.	1 case.
	Bacillus diphtheriæ.	1 "
	Bacillus coli communis.	1 "
	Unidentified diplococcus.	1 "



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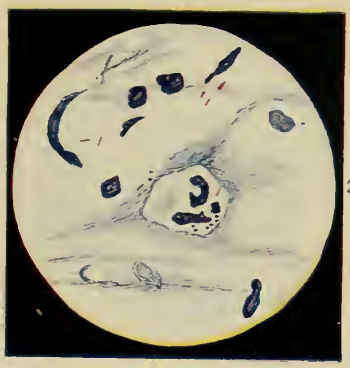
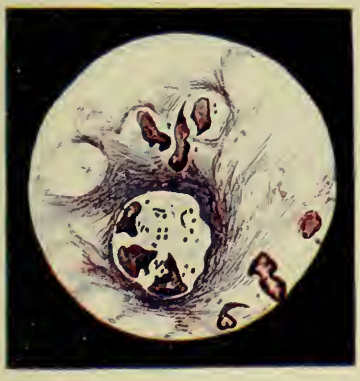


2

1.—Shows in the Same Field Pus Cells Containing Tubercle Bacilli and Streptococci (Carbol Fuchsin and Methylene-blue).

2.—Organisms Similar to (1), but Contained in the Same Pus Cell.



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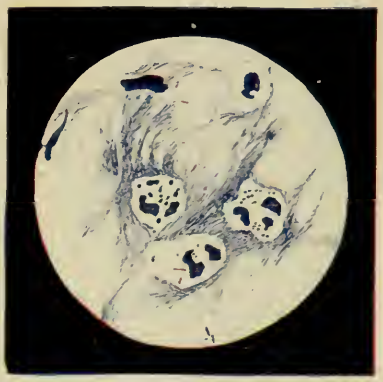
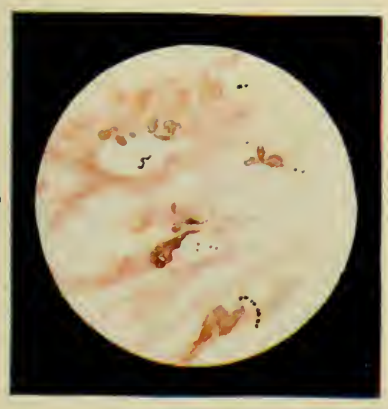


4

3.—A Large Pus Cell Containing a Tubercle Bacillus and Many Staphylococci (Carbol Thionin).

4.—Pus Cells Containing Staphylococci, Pneumococci, and One Cell Containing a Tubercle Bacillus and Pneumococci (Carbol Fuchsin and Methylene-blue).



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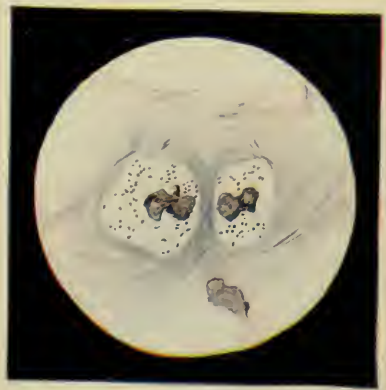

6

F. Webb.

5.—The Micrococcus catarrhalis (not Taking Gram's Stain) and the Pneumococci and Tubercle Bacilli (Taking Gram's Stain).

6.—The Influenza Bacillus (Carbol Thionin).

In lung cavities, an organism resembling the Klebs-Löffler bacillus is frequently found, and it has been called the "pseudo-diphtheria bacillus pulmonalis." It is often indistinguishable morphologically and culturally from the true diphtheria bacillus, but we have never found it virulent for guinea pigs. Some of the cultures we have been forced to regard as true diphtheria which had lost its pathogenic power.

Our studies have not enabled us to draw any positive conclusions, though we are convinced that in pulmonary tuberculosis, mixed infections play an important part in the production of symptoms and in the course of the disease.

Taking the staphylococcus as being one of the most frequently present of the mixed invaders, I have grown numerous colonies from every sputum, from fifty different patients. Microscopic preparations have revealed it in almost every case (Plate II), and it has frequently been observed within the pus cells in the sputum.

In infections (Ricketts, '06) the staphylococcus attracts large numbers of leucocytes, and the pus does not coagulate. The substance which attracts leucocytes is heat resistant, since killed cultures will cause abscesses. In all but the most superficial lesions a characteristic result of infection is that of cell necrosis and the liquefaction of tissues. Neisser and Lipstein state that the necrotizing substance is a soluble toxin, since culture filtrates cause marked necrosis of the internal organs (liver, heart, kidney) when injected. "Hence, in staphylomycosis we can distinguish two active substances (v. Lingelsheim, '98), the leucotactic substance in the bodies of the cocci, and the more important soluble staphylotoxin, which exercises not only a local but also a general toxic action on the body (Neisser and Lipstein).

The extensive necrosis of carbuncles is an every-day observation produced in an afebrile manner by the *Staphylococcus pyogenes*. The sputum from many cavity cases has developed, on culture, an overwhelming number of *Staphylococcus pyogenes albus* or *aureus* colonies, and microscopic examination has shown staphylococci as well as diplococci to be contained within the pus cells. With such knowledge of its necrotic powers, it would certainly seem just to attach to this organism some of the blame for cavity formation.

The treatment of the mixed infections of pulmonary and other forms of tuberculosis must naturally be founded on the results of investigation of each individual case. This study may be approached by three methods:

1. A carefully selected portion of sputum may be examined microscopically, and the various organisms may be differentiated by methods of staining.

2. A portion taken from the interior of the sputum mass may be planted out, and the growing colonies investigated.

3. The opsonic index of the patient may be studied in connection with the different bacteria thrown from the sputum.

The writer's plan, in one hundred cases, has been to depend chiefly on the first two methods of investigation.

In the first method especial care has been exercised in the examination of the pus cells as to their bacterial contents, for it is only logical to conclude, since Wright's completion of Metchnikoff's theory, that the bacteria found in the dead leucocytes have been actively campaigning.

1. Carefully selected portions taken from the interior of sputum mass are teased on three separate slides.

2. These slides are fixed by placing them in a supersaturated solution of mercuric chlorid for three minutes; then they are washed with water and dried.

3. One slide is stained by the regular carbol-fuchsin, methylene-blue method.

The second slide is stained according to Gram's method.

The third slide is stained with carbol-thienin.

Reference to the plates will convey some of the results of each method.

It must not be concluded that absence of bacteria from the pus cells disproves the activity of organisms found on the slides, for as the phagocytosis of the tubercle bacillus is most variable, as evidenced by sputum examination, so is the phagocytosis of these secondary organisms; neither in such investigations is phagocytosis of any prognostic value.

The method of growing will confirm these examinations, and will frequently produce organisms not observed by the microscope.

The technic of the writer has been to tease out a very carefully selected, small portion of sputum on blood agar in Petri dishes or tubes. On this medium the chief organisms will grow very rapidly. The *Staphylococcus pyogenes albus* (or *aureus*) has always been found, and is readily identified. As a general rule the pneumococcus will form a green-looking colony, and the *Streptococcus pyogenes* a hemolyzing colony, so that these organisms can readily be picked out for transplantation for vaccine-making.

The differentiation of the pneumococcus from the streptococcus is by no means a simple task, and herein, probably, lies the reason that investigators differ in their results of frequency. For practical treatment this differentiation is not necessary, and the writer has recently adopted the term of pneumostreptococcus as an escape from the difficulty, a term which will include both organisms. A pneumostreptococcus has been grown from every case.

The third method of ascertaining the activity of these secondary bacteria, testing the patient's resistance to them, as measured by their

opsonic indices, is a laborious and unnecessary procedure. In repeated instances patients have been found with a low index to their own staphylococcus and pneumococcus, and in febrile cases they have shown fluctuating indices to these as well as to the tubercle bacillus.

Approaching now, more directly, the remedial agents for these infections, it has been repeatedly observed by Wright that, in the cure of lupus and subcutaneous tuberculosis, no progress was made with inoculations or tuberculin unless the secondary bacteria were removed. Hence the remarks contained in the paragraph quoted at the beginning of this chapter.

The writer tried for weeks to improve a sycosis by inoculations of staphylococcus vaccine; an opsonic index to the tubercle bacillus of 0.5, heated serum 0.3, later gave a clue to a more exact diagnosis of tuberculous sycosis, and the addition of tuberculin to the staphylococcus vaccine soon produced a complete cure.

To those who have watched the almost miraculous disappearance of boils following the inoculation of an homologous staphylococcus vaccine, and who have also seen a pneumococcus pus pouring from an ear disappear entirely in a few days through the exploitation of the appropriate vaccine, it will cause no surprise to learn that comparatively similar results have been obtained in the reduction of sputum of consumptives by the application of similar methods.

It has been the writer's lot to have chiefly had to apply these methods to patients with long-standing disease, old campaigners who have for years tried every form of treatment. These patients, through autoinoculations and through the swallowing of their sputa (Wright, '04),[1] have largely worn out their mechanisms of defense, leaving little machinery to place in motion.

Vaccines have been made from pure cultures derived from patients' sputa, according to the technic of Wright, and inoculations have been made at intervals of from five to ten days. The doses, in all cases, have been small to begin with, usually about 20 millions of any vaccine, and the amount has been increased to rarely more than 150 millions. The time of day preferred has been within an hour or two after meals, when the receptor cells have presumably been occupied in the absorption of nourishment, and constitutional symptoms are at such times less likely to follow.

It has been observed that a very small dose of tuberculin inoculated into a fasting patient has caused a reaction, whereas the same dose given

[1] Wright has shown considerable variation in the bactericidal power of serum following on the drinking of typhoid vaccine. His experiments are suggestive, and there is a wide field for investigation of the consequences of the tuberculous swallowing their sputa.

several times before, but following a meal, had never done so. This may be the reason why different degrees of negative phase are found by different workers. Perhaps a homely instance of toxic effect is the feeling resulting to the unaccustomed from smoking tobacco before breakfast.

The reader who is familiar with Ehrlich's theory of immunity and with von Dungern's ('03) experiments in connection with the immunization of rabbits against the blood of a particular variety of crab will recognize that the occupation with food of the receptors which subserve the nutrition of the cell may delay the incorporation of the toxic elements of the vaccine with the cell protoplasm.

To ascertain if leucocytes had a preferential appetite for one organism more than for another, an experiment was undertaken with the blood of a patient suffering from a mixed infection of tubercle and staphylococcus, and who received inoculations for both. The opsonic index to each organism was found to be 1.2. The tubercle and staphylococcus emulsions were then mixed, and the opsonic indices again taken. The mixed organisms found in the leucocytes were counted, and the index to tubercle was found to be 1.1, and to staphylococcus 1.2. These results, practically identical, were confirmed by a second experiment with another patient.

It would, therefore, seem that, given sufficient opsonin, the white-blood corpuscle is impartial in his selection of foes.

All patients affected with chronic pulmonary tuberculosis in an arrested condition have been found to have low opsonic indices to the tubercle bacillus as well as to their secondary organisms. The condition of such a patient is best described by comparing him to a country mastered by the armed occupation of mixed hosts.

It may be profitable to cite a few illustrative cases of different types of mixed infection:

Case I.—Mrs. B., age twenty-six, sent to Colorado Springs, November, 1906, for catarrhal phthisis. Infiltration and sticky râles at apices of both lungs; scarcely any cough; no expectoration; gradual gain in general health till February, 1907, when she had an attack of influenza, followed by a cough and purulent expectoration, with coarse râles at both apices.

Sputum.—No tubercle bacilli; pneumococci and staphylococci, the former found frequently within the pus cells. The sputum was planted out, and pneumococcus and staphylococcus colonies grew, the former outnumbering the latter. Vaccines were made, as the patient showed after several weeks no ability to conquer her cough.

March 10th.—Inoculation of 20 millions of pneumococcus vaccine. Sputum increased in amount for several days, followed by a decrease.

March 16th.—Inoculation of 30 millions of pneumococcus vaccine;

bronchial wheezing which had been annoying patient all disappeared; no expectoration for several days.

April 1st.—Râles at both apices now again of the sticky character; three more inoculations were given with the addition of some staphylococcus vaccine, and small doses of Koch's new tuberculin.

October, 1907.—Patient still without cough or expectoration. Sticky râles persist at each apex. Opsonic index to tubercle persistently low; inoculation of Koch's new tuberculin started, as climatic help has not produced a complete cure.

This case would seem to illustrate the theory held by some that the influenza bacillus is necessary for the introduction of the pneumococcus.

Case II.—*May, 1907.*—Mr. G., age forty, had pulmonary tuberculosis for six years; cavity in each lung. For some months past was suffering from persistent fever, following an attack of influenza, accompanied by excessive expectoration; sputum measured six ounces. Extensive sycosis (staphylococcus) of mustache and hair in nostrils, of several years' duration.

Sputum.—Tubercle bacilli, pneumostreptococci and staphylococci present; some phagocytosis of all. Cultures were made, and colonies of *Staphylococcus aureus* predominated. Inoculations of a staphylococcus vaccine temporarily increased the amount of sputum, soon followed by a decrease to less than two ounces.

The sycosis, which was assisted by epilation (former epilation had failed to cure), rapidly disappeared, as also did the patient's fever. A gain in weight of over thirty pounds was made, and a bedridden patient was restored to comparatively good health.

Case III.—*January, 1907.*—Miss D., age forty, had pulmonary tuberculosis eight years. Cavity in left apex. Profuse expectoration for six years; amount of sputum daily, four ounces.

Sputum.—Tubercle bacilli, diplococci, staphylococci, some phagocytosis of all shown by examination of pus cells. Cultures showed a few colonies of a pneumostreptococcus, enormous numbers of *Staphylococcus aureus* colonies; vaccine made of the latter.

Following the first few inoculations, the sputum was reduced to barely half an ounce; a clearing out of her cavity at night, caused by recumbent posture, was completely stopped, and for the first time in eight years the patient was able to lie down and sleep through the whole night undisturbed by coughing.

October, 1907.—With the exception of an exacerbation lasting a few days this summer, the same improvement continues.

Results in Inoculated Cases

The result in fifty cases inoculated by the author with homologous vaccines prepared from the mixed organisms are best summed up as follows:

1. In no case has a patient been harmed.

2. Many patients have had exacerbations more rarely.

3. Expectoration in nearly all cases has been lessened; nocturnal coughs have frequently been eliminated.

4. In some cases a chronic catarrhal hoarseness has entirely disappeared.

5. Concomitant pus affections have cleared away, such as suppuration of ears, staphyloccic acne, and sycosis.

6. When these vaccines have been combined with small doses of Koch's new tuberculin, spreading infiltrations have been averted and cleared up.

7. In a case which displayed tubercle bacillus, streptococcus, pneumococcus, staphylococcus, and *Micrococcus catarrhalis*, the latter was entirely eliminated by appropriate vaccine, and the amount of sputum was reduced from four ounces to less than one ounce daily.

8. Evacuations of four to six ounces of sputum daily from cavities have, in several cases, been reduced to less than one ounce.

The impression has been gained that the "bronchorrhea" type of cases has, perhaps, received less benefit connected with the reduction of sputum than the "cavernous" type, and a possible explanation may, perhaps, be found in the results of inoculations of staphylococcus vaccines for acne and boils. Owing to the difference in the access of blood to the skin surface and to the subcutaneous tissues, the boils have been found much more amenable to increased opsonic lymph than the acne spots.

The experience of the writer has been limited to vaccines made of the staphylococcus, streptococcus, pneumococcus, influenza bacillus, and *Micrococcus catarrhalis*. At the present time a method is under trial which may very materially simplify the making of these vaccines, and also produce them more potent, as a result of lessened attenuation from transplantation. The sputum is teased on a slant of blood agar, which is prepared from each patient. Colonies develop in approximately the same proportion in which the organisms have been active. These are washed off in salt solution, the emulsion thoroughly shaken, a slide prepared for enumerating, and the production is immersed in a water bath at 60° C. for one and a quarter hours. The vaccine so made is tested in the usual manner, and, when counted, is decanted to the required dilution.

This method has been tried with success in purulent ear and bladder infections, and so far has given excellent results in pulmonary tuberculosis. It is not so scientific nor so exact as that of isolating each organism. The count of each organism in such a mixed vaccine is difficult, it often being impossible to say what is a pneumococcus and what is a

staphylococcus, yet an error within a few millions is practically immaterial in vaccine therapy.

A lasting immunity must not be expected from inoculations of these vaccines, just as a lasting immunity to the tubercle bacillus is unattainable by any tuberculin administration. After the apparent maximum results have been obtained, most patients have been kept in touch by inoculations at intervals of a few weeks.

In conclusion, the author would put forth the earnest plea that these potent remedies be used early, while the machinery of immunization is yet unworn, and that they be added to the tuberculin treatment so well advocated by Trudeau and Wright. Then the ranks of the advanced tuberculous will be lessened.

CHAPTER III

HYGIENE, DIET, AND OPEN AIR IN THE TREATMENT OF TUBERCULOSIS

HOME TREATMENT BY SANATORIUM METHODS

By THOMAS D. COLEMAN

Cases cared for in the home are for the most part omitted in statistics because most doctors do not keep accurate case histories, and those who do, do not always report them; on the other hand, most sanatoria do report their cases, and many of them do not accept patients who are in advanced stages of the disease.

Flick, Pratt, and others have shown how, with a little trouble, a small expenditure of money, and a directing hand, even the slum dweller may have his sanitary surroundings improved and the length of his life increased. They have recently been giving object lessons in this direction that are far reaching in their influences for good. They are showing not only to the laity but to the profession the beneficial results that may be obtained even in insanitary surroundings. The tuberculous patient is being taught that even in the slums and tenement-house districts their surroundings may be improved; they are being taught the value of order and cleanliness, of wholesome food, and the necessity of fresh air. (See Appendix.)

Instead of living in stuffy, ill-ventilated quarters which the sun never reaches, the patient is being taught to use the courtyard of the tenement, in which a tent may be erected, or a balcony over which a suitable awning may be placed to protect it from the inclemencies of the weather; or even the roof of the house may be utilized for the erection of a tent. On sloping roofs a floor may be necessary with banisters around, but on a flat roof these may be dispensed with. These advantages may be obtained by almost anyone who will take the trouble or make the effort. These accessories to the home may often be obtained by the expenditure of a few dollars. In passing a palatial residence only recently, I had impressed on me how, in the essentials, the rich have little advantage of the poor. The stone mansion was imposing in its grandeur. It occupied a large plot of land, which was made more beautiful by the land-

scape gardener's skill; huge stone pillars supported the ornate iron fence that inclosed it. One could not but envy the possessor, but a glance a little farther back made the envy give place to pity—an unostentatious tent in the background, on the lawn, told the tale—the fight for life was going on not in the mansion, but in the tent.

In presenting the detailed treatment of these cases, I have not considered it desirable to separate the sanatorium from any other intelligent routine treatment, for the reason that in the homes of the well to do the sanatorium treatment may be equaled, if not surpassed; in the homes of the less well to do, even in the houses of the poor, when the patient cannot or will not go to the sanatorium, an approximation to the accepted standards should be made, as far as the intelligence and ability of the patient will permit.

FOOD

Tuberculosis formerly was generally called consumption, because of its destructive metamorphosis, and in the literature of medicine we still find the terms "galloping consumption," "quick consumption," etc. In both acute and chronic tuberculosis the subcutaneous fat disappears, the muscles decrease in size and power. To counteract this retrograde tendency, an intelligent direction of the food is necessary. This direction not only includes the quality and quantity, but its preparation as well.

It has been determined by physiologists that a man of average size, doing ordinary work, requires about 120 gm. of albumin, 50 gm. of fat, 500 gm. of carbohydrates daily in order to replenish his bodily wastes, and he thrives best on a mixed diet. An adult of average size consumes about 3,000 calories of combustible material per day, and since albumin yields 4.1, fat 9.3, and carbohydrate 4.1, it will be found that the aforementioned dietary contains approximately 3,000 calories. A tuberculous patient requires even more than this.

While this serves as an index, it must not be followed too closely, since elements of error creep in that cannot be measured mathematically. For example, food constituents vary in composition in their raw state and in preparation. Again, the question of taste comes into consideration, and with it problems of digestion and assimilation, so that we must make a liberal allowance for these factors. Long before Pavloff chronicled his valuable observations, we were familiar with the expression, "his mouth watered for food"—the physiologic interpretation of which is that the smell or sight of food excited the salivary glands, and thus prepared for the digestion of food. We have known for many years that the opposite holds true: giving unappetizing food or giving food to an individual who is under great mental stress, the food is not only hard to swallow, but difficult of digestion as well. Again, I have found that

a large percentage of my tuberculous patients suffer from gastric catarrh, which not only blunts their appetites, but impairs their digestion.

An experience of two decades has brought me to this attitude in prognosis: if, after two or three months, the patient can take the amount of food that he requires, and gains weight on it, my prognosis is influenced favorably. In other words, an engine is no stronger than its boiler, and a man than his stomach. I have rarely found the tuberculous process to be advancing when the patient has been steadily gaining weight for any length of time. Proper nourishment, then, is of the first importance, for patients do well even under adverse climatic and other conditions, but they cannot improve without food, and an abundance of it. We must also introduce such aids to digestion as the individual case may require. Food values in calories of energy have their true place, and hold good for the healthy individual, but they often savor too much of the mechanical in those who are sick and have disordered digestions.

The most reliable guide of the patient's improvement is his gain in weight. He should be weighed each week, at the same time of day and under the same physical conditions, and his food consumption should be regulated by the result. The following table, from calculations made by Boas and Cornet, gives the food values, in calories, in 100 gm. or 0.1 liter, of the articles of diet mentioned:

Milk	67	Salmon, raw	133
Skimmed milk	40	Haddock, raw	61
Cream	215	Sole, raw	95
Buttermilk	41	Perch, raw	76
Butter	756–807	Oysters, raw	20
Pot cheese	179	Pickled herring	246
Swiss cheese	340	Smoked salmon	224
Scrambled egg	188	Kiel sprats	243
One egg	70–80	Caviar	278
Beef, raw	119	Rice cooked in milk	177
Beef, boiled	209	Mashed potatoes with butter	127
Beef, fried	214	Spinach, raw	39
Veal cutlet, raw	142	Spinach, boiled	166
Veal cutlet, fried	230	Purée of beans	193
Calves' brain, raw	140	Peas	75
Sweetbreads	90	Beans	41
Pork, fat	313	Asparagus	18
Bacon	617–761	Farina pudding	288
Chicken (breast), raw	100	Omlette soufflée	237
Tongue	393	Noodles (macaroni)	353
Smoked meat	255	Raw sugar	406
Smoked ham	438	Corn bread	203–232
Pomeranian goose's breast	381	Pumpernickel	229
Bologna sausage	445	Wheat bread	229–260
Liver sausage	290	Zwieback	332–358
Carp, raw	93	Cakes	374
Pike, raw	72	Corn brandy	280
Turbot, raw	101	Carrots	41
Trout, raw	106		

In no other chronic disease is abundant feeding so essential. It must be carried out, not only through the abundance of food furnished, but by its quality, by its variety, by its method of preparation, by digestive stimulants and aids, and, in special cases, by the employment of the stomach and rectal tube. While it is possible to overburden the digestive tract of the patient, this danger is insignificant compared with the likelihood of not getting enough food to make good his wastes, and to fortify him against the ravages of the disease. That diet is best which taxes the alimentary powers least and furnishes the greatest amount of nourishment.

The demand for an excess of fats is in no disease more pronounced, and was early recognized in the employment of cod-liver oil, under the impression that it was a cure for tuberculosis. **Milk**, fresh and pure, or in various modifications, is of greatest value in many cases. When there is hyperacidity, and the milk forms large curds in the stomach, a little limewater added to it will overcome the difficulty. In other cases, milk diluted with an equal part or a third of vichy or ordinary carbonated water will be tolerated when plain milk will not. Similarly, buttermilk is not only more palatable to some, but is more easily digested, and koumiss, matzoon, and milk artificially fermented ("*lactobacilline*") are all varieties of milk to be considered and recommended as the case requires. The patient should take from one to two quarts of milk daily, plain or modified, in addition to other food.

Eggs, in nutritive value and ease of assimilation, occupy a position second only to milk, and are subject to a like variety of preparation. The simplest form in which the egg may be administered is egg albumen, and I have found that not only invalid adults, but babies at the breast, can take this form of nourishment when they can take no other. The way in which I usually have it prepared is to take the white of the egg, clip it with scissors to keep it from cohering, add a little crushed ice, orange juice, and a pinch of sugar. The most delicate stomach will not only tolerate this, but the patient will relish it. If for any reason, particularly in the case of babies or patients suffering from intestinal tuberculosis, the orange juice is contraindicated, arrowroot or oatmeal or barley water may be substituted, and a flavoring extract or cognac brandy may be added.

In the majority of cases the whole egg is taken. At the beginning a little sherry or port wine in the bottom of the glass, then the egg, and on top again the wine, making a sort of "egg sandwich," may be used, or whisky or brandy may be so employed, but soon these may be dispensed with and the egg swallowed without them. I have had patients take as many as twelve eggs daily. Again, patients may take the eggs in milk, or with the addition of whisky or brandy, making an eggnog,

or with sherry or port wine, making a sherry- or port-wine flip. In the matter of cooking, eggs may be taken soft boiled, shirred, poached, or scrambled, or they may even be hard boiled. Indeed, they occupy a place in our dietary that is insufficiently appreciated. They are used in all batter breads, meringue, and cakes.

Meat comes third in the dietary of the tuberculous patient. Those who are robust take meat of many kinds and variously prepared. It may be stated generally that fried meat of any kind is harder to digest than when prepared in any other way. I think it is true of meat as of milk: that it is easiest digested raw, so that it will be found that the raw-beef sandwich can be digested when no other form of solid food can. The objections to taking meat raw come, first, from our natural aversion, which, strangely enough, does not pertain to oysters, clams, etc., and to the parasites (which are destroyed by cooking). Again, cooking makes the connective-tissue portion of the meat more digestible.

Next to this, and even beyond it in certain asthenic cases, is the squeezed-beef juice,[1] and largely because it may be swallowed without mastication.

In the matter of meat, the flesh of any edible animal is wholesome if properly seasoned and cooked. In this respect the taste of the patient should be consulted as far as possible, it being borne in mind that shellfish are less nourishing than many lentils, and that pork and veal are difficult of digestion.

Prepared Foods.—Of the prepared foods, some are of value. Among the first may be mentioned the milk preparations. Of all of these I may say that, so far as my experience goes, they are makeshifts; they may aid in nutrition, but are insufficient of themselves. The beef preparations depend largely for their nutritive value on the wine which they contain, and Graham Lusk has recently shown that one of the more popular of these contains no more nutrition than an equal quantity of milk. When administering them in tablespoonful doses they are totally inadequate.

Alcohol.—It has been proved that alcohol, when used to excess, not only does not protect the individual from tuberculosis, as was formerly believed, but absolutely predisposes him to it. On the other hand, Professor Atwater and others have demonstrated beyond question that alcohol, in moderation, is a food and beneficial to the system. This he is able to maintain not only from his experiments, but from the fact that there is no hardier stock of people to be found on earth than the wine-drinking nations.

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[1] This is made by taking blocks of beef two inches square (round steak is best for this purpose), putting them into a red-hot skillet, and cooking them quickly, turning the while. They are then gashed with a knife and squeezed with a meat press or lemon squeezer into a cup standing in hot water. This keeps the juice hot and makes it more palatable.

It has been shown that alcohol is a negative food; that, in its immediate oxidation, it saves tissues that would otherwise be expended in life processes. In moderate amounts it stimulates the appetite, improves digestion and reduces the temperature, and diminishes the night sweats. The excessive use of alcohol not only fails to stimulate, but depletes the system; the continuous use of it also leads to the habit, so that the physician and the patient must be constantly on guard. Alcohol taken unwisely may not only destroy the appetite, but leads to poverty, degradation, and crime. Wisely employed, it improves the appetite, makes the digestion better, and protects the tissues.

Whenever the digestion will permit, an excess of **fats** should be furnished; e. g., the fat of pork, mutton, fowl, beef, butter, cream, olive oil, fatty fish (e. g., Spanish mackerel, pompano, eels, salmon, shad, sardines, etc.). For a similar reason, beans and peas are to be recommended because of their high nutritive value.

Carbohydrates are fat producers, and these should be prescribed liberally. Among these may be mentioned corn, wheat, graham and batter breads, pies, puddings, and cakes; cane sugar, maple sugar, and honey, all admitting of various combinations and an infinite variety in preparation.

Among the proteids, milk, eggs, and meat form the triumvirate; all may be taken raw, or prepared in the more tempting ways known to the culinary art.

Dietaries.—The following dietaries are applicable to the average incipient or moderately advanced case, it being remembered that the individual taste and the state of the digestive apparatus of the patient cannot be disregarded. It should also be borne in mind that not only the time of feeding, but the quality and (minimum) quantity of food must be prescribed by the physician:

Breakfast, 8 A.M.—Fruits; cereals; one raw egg; three glasses of milk; coffee; toast.

Breakfast, 10 A.M.—Two raw eggs; two glasses of milk; crackers; pretzels.

Dinner: 12.30 P.M.

Cream of Tomatoes.
Broiled Sirloin Steak.
Stewed Chicken.
Boiled White Potatoes. Stewed Onions. String Beans.
Steamed Rice. Macaroni.
Salad.
Apple Tapioca. Rice Pudding.
Crackers. Cheese. Nuts.
Coffee.

or

Purée of Peas.

Breast Spring Lamb. Mint Sauce.

Prime Ribs of Beef.

Boiled White Potatoes. Baked Sweet Potatoes.

Spinach. Stewed Tomatoes.

Lettuce Salad.

Baked Apples. Cup Custard.

Crackers. Cheese. Nuts.

Coffee (*demi-tasse*).

4 P.M.—Two raw eggs; two glasses of milk; crackers; pretzels.

Supper, 6.30 P.M.—One raw egg; three glasses of milk; tea; toast; fruit.

8.30 P.M.—Two glasses of milk.

Summary.—Six raw eggs, three quarts of milk, and full meal (Stockdale).

Another dietary is as follows:

7.30 A.M.—Milk, ½ pint.

8.30 A.M.—Milk, ½ pint; bread or toast, 2 ounces; butter, ½ ounce; 2 ounces fish or bacon, etc., and an egg.

10.30 A.M.—Milk, ½ pint.

11 A.M.—Milk, ½ pint; bread, 2 ounces; butter, ½ ounce; fish, 2½ ounces; meat, 3 ounces; milk pudding, 5 ounces.

Dinner.—Similar to lunch, but meat, 2 ounces.

Cornet, who adopts a somewhat lower fat standard for the diet in health than do these authors, is in the habit of prescribing for his patients on the following lines:

First Breakfast, 7 A.M.—Milk (cocoa or coffee), ½ to 1 pint, with one or two eggs stirred in; or gruel, or meat, bacon, bread and butter.

Second Breakfast, 9 to 9.30 A.M.—Milk, ½ to 1 pint; or 3 ounces strong wine (sherry, port, marsala), bread and butter.

Noon Meal, 1 P.M.—Soup; *entrée*; fish; roast venison; fowl, with vegetables; preserves and salad; pudding; bread, butter, and cheese; 3 ounces red wine, or ½ pint beer.

Afternoon Meal, 4 P.M.—Milk (cocoa), ½ to 1 pint, with one or two eggs stirred in; bread and butter (honey).

Supper, 7 P.M.—Roast meat; vegetables; cold meat (ham); roasted potatoes; bread and butter; 3 ounces wine, or ½ to 1 pint beer or milk.

9 P.M.—Milk, ½ to 1 pint; 1 zwieback, cakes, or bread.

Lucas gives the amount of the various forms of food which are necessary as follows:

Breakfast.—Porridge, ½ pint, with 2 ounces of sugar; 2 rashers of bacon and 2 eggs (or chop, steak, or fish); bread, 4 ounces; butter, 2 ounces; ½ pint of tea or coffee; milk, 1 pint.

Midday Meal.—Soup (optional); fish, 3 ounces (or poultry), with butter, 2 ounces; 2 or 3 slices of meat, 4 ounces; potatoes, 4 ounces; cabbage and other vegetables, 4 ounces; pudding (various kinds), 6 ounces; cheese, 2 ounces; bread, 4 ounces; butter, 2 ounces; milk, 1 pint (or cocoa), with one or two eggs stirred in; bread and butter (honey).

Supper preceded by one fourth to one half hour of rest.

Supper, 7 P.M.—Roast meat; vegetables; cold meat (ham); roasted potatoes; bread and butter; 100 c.c. of wine, or ¼ to ½ liter (quart) of beer or milk.

9 P.M.—Milk, ¼ to ½ liter (quart); 1 zwieback, cakes, or bread.

The rest before meals, which I prescribe even for fairly strong patients, increases the consumption of food.

Tuberculous patients with a temperature seem to be able to take and digest an amount of solid food which under other febrile conditions would not be tolerated. Any dietary suggested will have to be modified to suit the individual. If any other argument was necessary, this is sufficient to justify the claim for constant medical supervision in these cases, and infinite tact and perseverance are necessary. The simplest diet is that of milk and eggs; if patients take enough of these, other food may be largely dispensed with, and yet, in the employment of these, tact and judgment will have to be displayed. A large percentage of patients can take raw milk—even many who think and say they cannot. Still, there remains a percentage of patients who cannot take milk at all, or for whom the milk must be modified in some way, or peptonized.

Appetizing and Bitter Tonics

When the desire for food is poor, appetizers and bitter tonics may be indicated. Among these may be mentioned alcohol, which in moderate amount, and either plain or with vegetable bitters, not only stimulates the appetite, but improves the condition of the body as a whole. In this connection the following will be found of service:

℞ Tr. nucis vomicæ ..... ʒij; 5 gm.
" gentianæ composit., } āā ..... ʒij; 60 "
" cinchonæ composit., }
M. Sig.: Dose ʒj, in a wineglassful of water before meals.

AIR AND ENVIRONMENT

The life history of the tubercle bacillus outside the body, and our knowledge of its existence in man and animals, all teach us that fresh air exercises an unfavorable effect on its growth. Tubercle bacilli dried and exposed to the sunlight lose their virulence in a few days; in dark, illy ventilated rooms they may retain it for many months. From the animal kingdom the same testimony is obtained; tuberculosis is not found in the monkey in his jungle life. In captivity it is the disease with which he is affected, and it probably accounts for more deaths than all other diseases combined.

The same evidence is furnished by the human family. Tuberculosis is comparatively rare in the rural districts. In the negro, in his uncivilized state and even in his state of bondage, it was comparatively unknown. Now the deaths in that race from this disease are three or four times as great as among the whites.

The congested districts of our cities—our slums, sweat shops, "lung blocks," etc.—furnish uncanny but instructive pictures to which we cannot shut our eyes. Fresh air in some of the abodes of the poor is more difficult to obtain than fresh food, and these "lung blocks" exact their tribute year after year. Fortunately for the human race, health boards and philanthropists are taking active hold of this problem, and are forcing conscienceless landlords to respect the commandment, "Thou shalt not kill." With these facts in our possession, it is easy to see the important rôle which pure air plays in checking the spread of the disease, and, therefore, the saving of human life.

It is not in the least necessary or even desirable to draw the line in this respect between the patient in the sanatorium or out of it; pure air and an abundance of it is a *sine qua non*. How this is to be best obtained is a problem that will differ in almost every case, and it will often tax the ingenuity and sagacity of the physician to the utmost. Manifestly, the problem is more beset with difficulties in the slums than in the abodes of the rich, and yet the prejudices of the latter, and their ignorance of hygienic laws as well, often present difficulties in this direction that are greater than the obstacles that poverty enforces in the case of the poor.

Whatever the financial condition or social status of the patient, fresh air must be demanded. This can be obtained in most instances by the physician of average ingenuity and whose heart is in his work, for be it said to the credit of the human race, it is ever ready to alleviate distress when the cause is just. I have never yet been refused aid for a sufferer for whose honesty I could vouch; so that, when improved hygienic surroundings are necessary, they can usually be obtained. It

is simply necessary to have a directing hand. Again, the district nurse has demonstrated how order and cleanliness may be brought out of chaos and filth, and Pratt and others have shown the scientific world what truly marvelous results may be obtained with unfavorable environment and unfriendly climatic conditions.

Education is the touchstone that brings about the wonderful transformation. Teach the sufferer that fresh air is not to be feared, but rather to be coveted, and a great stride in the fight will have been made. The temperature, when cold, or even if it is raining or snowing, does not prevent living a large portion of the time in the open air. It is essential to keep the body warm and dry by appropriate covering. At a minimum, eight to ten hours a day should be spent in the open air, and as much more as practicable, and a tent life away from the dust-laden and polluted air of cities is to be desired. If a tent life cannot be obtained—and it is not essential—as near an approximation as the means and environment of the patient will admit must be secured. He must live out of doors while the sun is up, and at night he must sleep with his windows open, though not in a draught.

It is to be deplored that civilized man tries to subvert the laws of nature. His life is spent in a race for wealth and preferment; and it too often happens that, when these are obtained, his capacity for enjoyment is gone, and all that is left to him is the privilege of bequeathing to posterity his life's blood coined into dollars. The business of life in the cities, whether it be to gain a bare subsistence or an effort to maintain social position, is subversive of the laws of nature. When the sun has sunk and the animal and vegetable world are at rest, the sweatshop worker, wearied in body, is busy at his task; the society devotee, with less excuse, in like manner weary of body, but from a different cause, in a different way—is busy. The bodies and minds of both are worn with the struggle, differing, it is true, in its aims and necessities, but similar in its ravages on the constitution.

Regularity and order are rules of our environment here; and the "early to bed and early to rise" is something more than a saw. It has been found that in this disease, especially, it is well to have patients follow, as nearly as possible, the course of the sun—to rise with it and to retire with it. Naturally, it is at best one of compromise and environment. The nearer we can approach the primitive state, the better.

In a tent existence, if possible, it is best to have the abode arranged so that the necessary toilet arrangements may be carried on in comfort, protected from the inclemencies of the weather which are to be encountered in any climate, but the sleeping and living of the patient should be in the open. This does not materially increase the expense of such an existence, for a tent, divided so that a closed portion is reserved for

these purposes, is not difficult to devise and maintain. The tent should, in all cases, have a floor elevated above the ground; the location should be well drained, and protected as far as possible from winds. These points are essential. As to surroundings of pines or fir trees, a sandy, porous soil, and a particular climate for the individual case, these are to be desired, but not essential.

When the patient is to be cared for in his home, the following details concerning his care are needful: Pure air, nourishing food, and the constant supervision of an able medical adviser. The patient's room should have an air capacity of approximately three thousand cubic feet; more does no harm, less makes an undesirable encroachment, but in any room not only is its size to be considered, but its location and ventilation as well. In northern latitudes, except, perhaps, in the summer, the room should have a southern, southeastern, or southwestern exposure, so that the benefit of the sun can be had a large part of the day; in tropical climates and in summer it may be desirable to change this.

The location, number, and size of the windows is also important. They should extend almost, if not quite, to the ceiling, and unnecessary brackets and abutments should be avoided, as they tend to catch dust. The angles of the room should be obliterated as far as possible; e. g., those between the floor and wall, and wall and ceiling. These may be rounded by metal or cloth, that may be painted. It is preferable to paint the walls, because they may then be cleansed more frequently and properly. Unnecessary curtains and hangings of every sort are to be avoided, as are also Venetian blinds, since, while they shut off the light and some heat, they still collect quantities of dust. To keep out the light when it is not desired, I know of nothing better than the modern opaque roller shade.

The floors, if of wood, should be painted or waxed, so that they may be cleaned readily. Whatever the floor surface, it should be made non-absorbing, so that it may be wiped up thoroughly. Carpets should have no place in the room, but a few rugs may be allowed. In this, as in many other ways, the rich have very little advantage of the poor. A Persian rug costing many hundreds of dollars, infected by tuberculous sputum, is not apt to be consigned to the trash barrel—it matters not what the wealth of the patient may be—whereas the morning newspaper, on which the cuspidor of the poor usually rests, is destroyed without hesitation when it becomes soiled.

With reference to cuspidors, while they are frequently spoken of in derision as an American invention, the writer, as an American, is glad to acknowledge their paternity. I believe them to be the greatest prophylactic device employed in preventing the spread of tuberculosis. Whatever may be said on this score, *pro* and *con*, it is certain that the

average poor patient is not able or willing to furnish himself with cloths or tissue-paper napkins into which to expectorate; and, while well-to-do patients are able, many are unwilling to take the trouble which the employment of cloths or napkins entails. I consider a cuspidor half filled with an efficient germicide, or simply water, less dangerous than any cloth on which the sputum is apt to dry, and from which bacilli must escape when they are used.

The chairs should be constructed for comfort rather than beauty, and some covering which may be disinfected and washed may be used. For the average patient some type of reclining chair (e. g., the average steamer chair, which is inexpensive) will be needed. The room should be on the first floor, so as to save the patient the necessity of climbing flights of stairs; it should be contiguous to the bathroom and toilet, so that the wants of nature, which are at times exacting, may be met without undue fatigue. It should be heated by hot water or steam preferably, and should be lighted by electricity. While no climate is universally adapted to all patients, still, the average case will do best in a mild, equable climate. A sultry, depressing climate is to be avoided; a bracing climate with plenty of sunny days is to be desired. Climates in which sudden atmospheric changes and high winds prevail are undesirable. The air should be free from dust and smoke, and the soil should be sandy or porous. A moderate altitude above the sea level is advantageous.

No hard-and-fast daily routine can be laid down for all patients. Any regulations that may be prescribed will have to be modified to suit the individual needs That employed at the Nordrach Sanatorium for convalescent patients able to take ordinary exercise will serve as a good working basis.

The following is an outline of the daily routine observed at Nordrach: The patient is called at seven o'clock in the morning, and in the colder months the windows of his room are then closed, in order that the room may be comfortably warm while he dresses. This closing of the windows at this time serves another purpose, in that the air of the room immediately tends to become "stuffy" to those accustomed to open-air methods. Consequently, there is a direct incentive to patients to get up. The patient then takes his temperature (rectal), and rises not later than 7.30, and has a shower bath, at a temperature, in most cases, agreeable to himself. He must avoid overexertion in drying himself. On completion of his dressing, he should open the windows.

Breakfast is at eight o'clock. Directly after breakfast, or at 8.30, the patient starts out for his morning walk, the length of which is graduated according to his condition. He walks deliberately, avoiding any strain, dyspnea, or perspiration, until he has arrived at his destination,

and waits there resting in the fresh air, but protected from the wind, until it is time for him to start home again.

At 11.45 he must be in his own room, where the windows have shortly before been shut, and must take his temperature. In five or ten minutes he should open the windows. Between twelve and one o'clock he lies resting, and alone, at full length on a sofa chair near the window.

At one o'clock he leaves his bedroom or shelter, and has luncheon, the principal meal of the day, with his family. Not later than 2.45 he must start on his slow afternoon walk, which is the shorter walk of the day. He rests, as before, when he arrives at his destination, and returns slowly, so that he reaches home at 5.30, or, if it is very cold, at about 4.45. He again takes his temperature, opens the windows, which have been closed shortly before his return, and rests alone until dinner time.

At seven o'clock he joins his family at dinner. After dinner he may spend half an hour to an hour in the dining room, or preferably in some suitable recreation room, under open-air conditions. The patient retires to his own room at nine o'clock, opens the windows, and takes his temperature. He should be in bed at 9.30, or not later than ten o'clock.

REST AND EXERCISE

A fundamental principle in the repair of tuberculous tissue is rest. A tuberculous joint is rested by putting it up in a splint; in cases of Pott's disease the patient is placed in a plaster-of-Paris corset; in tuberculous pleurisy, limit the excursions of the chest by means of adhesive strips; in pulmonary tuberculosis, if the process is active, general rest is prescribed.

To those who have not made a special study of the disease, the good results obtained by rest would seem almost chimerical, and yet they are demonstrable verities. Even without the administration of drugs the fever disappears, the night sweats diminish, the cough grows less, and the patient takes on flesh. I think this doctrine of rest is not now disputed by those having considerable experience in the treatment of this disease. It was on this theory that Forlanini, and later Murphy, Brauer, and others, suggested the plan of obtaining rest for the tuberculous lung by introducing nitrogen gas into the pleural cavity, thus causing the lung to collapse, and producing a state of rest which lasts until the gas is absorbed.

Rest does not cure all cases of tuberculosis, but it is always indicated where there is hyperpyrexia, where the night sweats are exhausting, where the cough is incessant, where the prostration and dyspnea are great, and where there is a tendency to pulmonary hemorrhage. Where the morning temperature is 99° F., and the evening temperature

100° F. or more, rest throughout the entire day should be enjoined. On the other hand, when the active stage of the disease is checked, exercise, intelligently directed and faithfully carried out, is to be prescribed. This must be undertaken gradually, and stopped at the return of fever or the production of too great fatigue.

Some exercise may be obtained, even by patients who are confined to their rooms, by the employment of massage. This stimulates the circulation and, to an extent, improves the general nutrition, but, like other exercise, must be directed intelligently; and, if it produces too much fatigue or brings about a rise of temperature, it must be curtailed or abated.

The simplest form of exercise outside of this is walking. This should be taken at first on the level, and afterwards, as the strength increases, hill climbing may be prescribed; it strengthens the leg muscles, improves the action of the heart, and thereby the general nutrition is improved. The hill climbing should be done gradually, and so that the ascent comes in the beginning rather than at the end of the walk. If fatigue ensues, a rest should be taken. The form of exercise should conform as nearly as possible to the tastes of the patient, and that which interests and attracts him should be indulged in as far as possible. This falls in line with the directions given for food. Within certain limits that food is most effective which is toothsome to the patient, and that exercise accomplishes most good which is most attractive or most interesting to him.

Dr. Paterson, of the Frimley Sanatorium, has prescribed a graded system of exercise which may be varied to suit the individual case, but

Fig. 152.—Grade 1. Baskets Holding About 12, 18 and 24 Pounds of Mold or Other Material. Patients carry these a distance of 50 yards up a gradient of 1 in 10.7 (rising 14 feet), 80 loads per day.

which may, nevertheless, be employed as a useful guide. He prescribed exercise and labor for two periods daily, each of two hours' duration. A patient is first placed on Grade 1, and then, as improvement shows itself, successively on Grades 2, 3, etc. If the work of the grade is

found to cause a rise of temperature, decrease of weight, or other bad symptom, the patient is at once placed on a lower grade.

The grades are as follows: (1) Slow walking exercise, beginning at two miles a day and gradually increasing up to ten miles a day; (2) picking up fir cones and firewood in the grounds, and carrying a half basket (weight, 11 pounds) to the stack; (3) carrying a full basket of firewood and cones (weight, 16 pounds); (4) carrying a half basket of gravel or stones from the gravel pit to the place where paths are being made or repaired (weight, 21 pounds); (5) carrying a basket of gravel

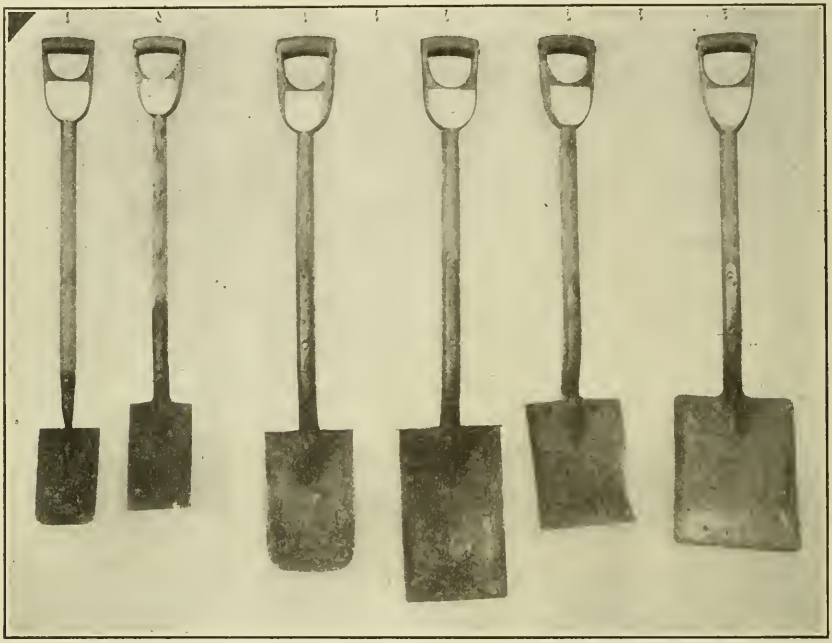

FIG. 153.—SHOVELS AND SPADES USED IN GRADE 2 AND 3 FOR DIGGING EARTH AND LIFTING IT INTO BARROWS. (Large shovels used also in concrete mixing as Grade 4.)

or stones, the weight of which is gradually increased up to 38 pounds (see Fig. 152); (6) rolling the grass or gravel (sixteen men pull a roller weighing 15 hundredweight; (7) digging ground already broken; (8) mowing grass with a lawn mower; (9) digging unbroken ground; (10) the same as under (9), but for six hours daily instead of four hours—i. e., the hours usually spent at rest are spent in labor.

No patient is classified on discharge as "arrested" unless for three weeks continuously he can pass one or other of the following tests:

Test A.—For a patient who earns his living by manual labor: To be able, on an ordinary diet and without rest hours, to use a pick and shovel, of the full size and weight, for six hours daily, and to maintain his health. The shovels and spades are of three sizes, weighing 2, 4, and

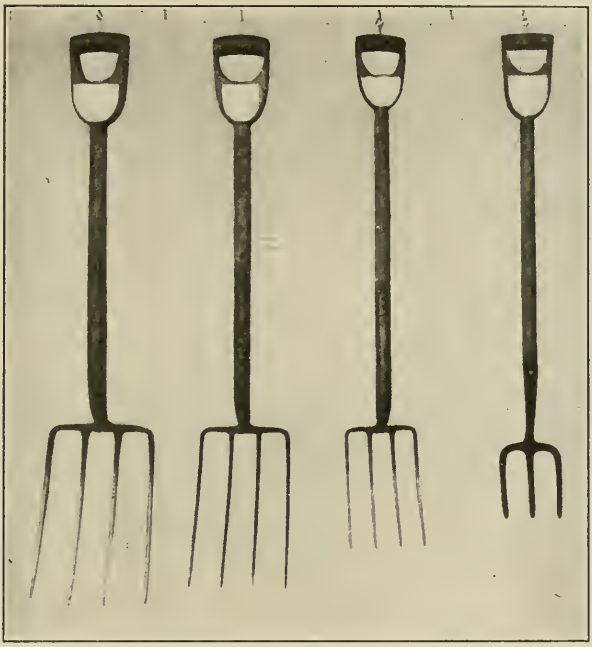

Fig. 154.—Forks of Different Weight for Graduated Work in Grade 2.

6 pounds, respectively. The picks vary from 3 to 7 pounds in weight (see Figs. 153, 154, 155).

Test B.—For a patient who does not earn his living by manual labor —clerks, shopmen, or salesmen: To be able, on an ordinary diet, to perform the labor of Grade 6, or for six hours daily, for three weeks, and to maintain his health. These patients are, as a rule, gradually brought up to Grade 9, and, when it is found that they can do this work, they are put back to Grade 6 or 7. The theory is that a man doing the work described under Grades 9 and 10, who, on discharge, will engage in work involving but little bodily exercise, would suffer in health from such an abrupt transition. Further experience is, however, necessary on this point. In some cases it is found that patients are unfit for Grade 9, but that they can be raised to a standard of labor which is equal to their ordinary work. These patients are tested before discharge on the grade to which they have attained, but they are not, as a rule, classified as "arrested."

On the supposition that the healthy portion of the lung undergoes hypertrophy, and that in this way loss of tissue is compensated, many authorities have advocated pulmonary gymnastics, but these have been opposed by Brehmer, Liebermeister, and others, for reasons already given, viz., that the nearer the diseased lung tissue approximates a condition of rest, the more readily it returns to the normal.

Fig. 155.—Pickaxes of Various Weights Used in Grade 4 for Breaking Ground, Excavating, Etc. This being the hardest work possible.

Within the last few months the untoward effects of exercise in the active stage of the disease have been impressed on me. An athletic young man, after a period of apparent quiescence in his lung trouble, suffered from a lively exacerbation in which he had serious and repeated hemorrhages, rise of temperature, etc. After the hemorrhages had ceased, and the temperature had been normal throughout the twenty-four hours for several days, and the patient was eating well, sleeping sufficiently, and taking some exercise in walking about the house and premises, I thought him strong enough to come to my office, instead of my visiting him, believing that the ride would not only be a diversion for him, but beneficial in other ways. Although the carriage ride, a distance of several miles, did not apparently fatigue him, his temperature rose that night to 105° F. Confinement to bed for several days promptly brought it down to normal, but the same result was produced by a second trip.

CLOTHING

Clothing, both for patients confined to bed and those going about, should be light but warm. In each case the patient will find that he can keep comfortable with less clothing by a little practice and the exer-

cise of a certain amount of will power. The end to be attained is to keep the body warm, but not to overheat it. Any clothing, whether bed or body clothing, which throws the individual into a sweat is bad. When confined to bed, it will often be found that an excess of covering is not needed if a hot-water bottle is applied to the feet. In the matter of body clothing, it is well to cover the body of the patient with woolen garments, summer and winter, the weight of the garments being governed by the temperature and temperament of the patient. If wool irritates the skin, cotton, linen, or silk undergarments may be worn. For sudden or great drops in temperature, overgarments of varying weights may be employed, and the patient should not start out on a long drive or walk without providing against these contingencies. The overcoat or wrap is especially to be commended, because it may be thrown off easily or put on as occasion demands.

HYDROTHERAPY AND HARDENING

The value of the bath in cleansing the skin of dirt and grease has been recognized from the earliest times. It not only improves the physiologic activity of the skin, but accelerates the circulation of the blood. The cold bath stimulates the peripheral nerves, and produces an invigorating effect on the body as a whole. At first the cold bath cannot be taken by all patients, the shock being too great.

Some patients cannot be hardened or educated into taking them. This is not a matter of mere volition on the part of these patients, but of temperament and constitution. These patients may greatly desire to avail themselves of this invigorating procedure, and may strive to coöperate to their utmost, but, in spite of all efforts, they fail to react. Instead, they feel depleted and benumbed; the head aches, the circulation is depressed. Instead of the tingling and bodily glow which should follow the bath, they remain chilly throughout the day; the extremities are cold and the nails and lips blue. These patients, many of whom are apparently strong, and others who are already depleted and debilitated from the ravages of the disease, should confine themselves to hot and lukewarm baths.

The process of hardening can be carried out in a larger percentage of cases than would at first sight seem possible, if the physician will exercise sufficient moral suasion, patience, and ingenuity; but when the aforementioned train of symptoms follow the cold bath, it should be abandoned. Even in the case of patients who can take it and experience a marked tonic effect therefrom, it should be dispensed with if there is a tendency to hemorrhage. Eliminating, then, those patients who for one reason or another cannot take the cold bath, it will be

found that by far the larger percentage can take it, and with distinct benefit.

In the case of feeble and more highly sensitive patients, they will have to be initiated by sponging a portion of the body with lukewarm water, and water to which alcohol, salt, or vinegar has been added; in the more difficult cases the bath should be preceded by dry friction; in fact, in all cases friction should be done during the process of the bath. Gradually the temperature of the bath may be reduced to 70° or 60° F.

Patients who react well, and who can practice friction on themselves, a cold plunge on rising, lasting from one to two minutes, followed by a brisk rubbing with a coarse bath towel, will be grateful and highly beneficial, producing a degree of exhilaration that can be obtained from no other procedure.

Some patients prefer to take a cold sponge to the waist, others a shower bath or a needle bath, instead of the plunge. The cold plunges or shower baths which are taken for their tonic effect do not take the place of the hot baths, which are taken to cleanse the skin of its impurities, and are demanded at least once a week.

SYMPTOMATIC TREATMENT

Debility and Loss of Appetite and Weight.—Second only to fever, in the earlier manifestations of tuberculosis, stand debility, loss of appetite and weight. These latter appear early in the course of the disease, frequently before the development of fever or sufficient physical signs to enable us in many cases to make a diagnosis, or in some cases even to suspect it. In other words, these symptoms are characteristic of so many conditions; they are due sometimes to overwork, improper food, distress and anxiety of mind, poor hygienic surroundings. In such cases tuberculosis is frequently little thought of by the doctor, and even less so by the patient and his friends, and yet the name consumption comes from these important symptoms which are present in varying degrees throughout the course of the disease. The main lesson which the physician should gain from this is to go more thoroughly into the history, symptoms, and physical signs of the case; in this way an error of diagnosis may be avoided and the patient's chances of recovery are greatly increased.

It is better to go to great lengths of trouble to no purpose than to neglect needful details of technic and later reap a harvest of barren regrets. It is not meant to be implied in this that an early diagnosis can always be made; it is only to put the physician on his guard and remind him of what he already knows—that it is never wise, or safe, or just, either to himself or his patient, to outline a treatment based simply

on the feel of the pulse, appearance of the tongue, and loss of flesh. Tonics and general directions do sometimes (for we have not yet, unfortunately, a specific for tuberculosis) bring about a restoration to the normal; but a large percentage of these patients will come back sooner or later with more prominent symptoms, when the real cause of the trouble will be made manifest.

With the diagnosis not in question, the symptoms of debility and loss of weight demand intelligent treatment, more than all others, taking the disease from its beginning to its end. As has been stated, patients do not gain in weight and strength when the tuberculous process is advancing and *vice versa*. Even under careful treatment, this, in the main, is true. The question of nourishment, then, is of the greatest importance, and what has been said of diet and hygiene will necessarily have to find some repetition and added emphasis here.

It is doubtful whether any considerable loss of weight and bodily vigor, in the absence of appreciable digestive disturbance, and frequently when it is present, often occurs without an impaired desire for food. Naturally, when the ingestion of food is not sufficient to make good the bodily wastes, whether from inability to obtain food either in sufficient quantity or proper quality, or from lack of desire in consequence of disease, the weight and bodily strength will wane. In tuberculosis these may be corrected by overcoming any digestive disturbance by forced feeding with wholesome food, and by tonics which stimulate the appetite, and thereby develop a craving for food. The condition may also be alleviated by the administration of remedies which look to more active blood building and improving the nervous tone.

If the patient has a coated tongue and a disturbed digestion, the first indication will be the relief of these. In the earlier stages of the disease this is not difficult. This having been accomplished, the quantity and quality of the food must receive consideration, and, as has been pointed out, these patients cannot only take, but often digest, a larger quantity of food than would be desired or could be cared for by an individual in health.

Other points in this condition to be borne in mind are that these patients, even when fever is present, can take a greater quantity of solid food and demand a larger percentage of fats than in any other disease. For these reasons the feeding requires to be more intelligently and firmly directed. The variety and preparation of food accomplish much, and to this, no doubt, is due much of the success which follows the treatment of those patients who have been pinched by poverty, and to whom such food is not only a novelty, but a luxury. It holds good, too, even with patients in easy circumstances who have paid too little heed to these essentials. Aside from these, the moral influence of the

physician must be brought into play to teach these patients to take more food than they actually crave.

In severe cases, liquid food, such as milk, broth, and eggs, will have to be employed, because they can be swallowed without mastication; but it has been found that a larger percentage of patients do best on solid food. When this cannot or will not be taken, in aggravated cases, resort to the stomach-tube may be necessary, but this is infrequent. Again, when much gastric disturbance is present, and no effort of will on the part of the patient will enable him either to take food or to retain it when introduced by the stomach-tube, or when the larynx is so affected that the swallowing of food or of a stomach-tube is distressing, and therefore impracticable, resort may be had to rectal feeding. Finally, some degree of nourishment may be obtained by inunction of the body with olive oil or cocoa butter. Some or all of these procedures may be necessary in appropriate cases.

Concerning the proteid foods, repetition will not be made here, but, in the matter of fats, the administration of butter and cream and oils is again emphasized. These are not only valuable as foods, but serve to keep the bowels open.

Cod-liver oil has long been employed in the treatment of tuberculosis, formerly with the idea that it had a specific effect on the disease (and it may be that the small amount of iodin which it contains has some effect), but now it is regarded chiefly as a food. It was formerly given in too large doses, and was often nauseous from the impure quality of the oil. This is largely corrected now, so that a comparatively pure and relatively tasteless oil may readily be obtained. The oil is best administered plain, as every emulsion and other combination is, in effect, a compromise with the patient. A little practice will make the patient not only take the oil plain, but like it. When this is not the case, a little whisky in the bottom of the glass, then the oil, and a little whisky on top, or sherry wine instead of the whisky, will readily disguise its taste. If these fail, an emulsion may be taken, or the oil may be combined with malt extract. It should be borne in mind, however, that the best of these preparations do not contain more than thirty to forty per cent of oil. When the oil is not borne well, the dose should be reduced to ten or fifteen drops at a time.

Olive oil is being much used now. It is not so nauseous as cod-liver oil, is better borne by the stomach, and exercises a wholesome effect on the digestive tract. Much of the so-called olive oil of the trade is cotton-seed oil. While not so palatable as olive oil, its nutritive value is high.

Anemia.—The blood should be examined not only to determine the percentage of hemoglobin, actual as well as relative, but also the number of red blood-corpuscles. Additional information, the exact value of

which is as yet indeterminate, may be obtained from the opsonic index, which at the present time seems to promise much. Impoverishment of the blood is usually coincident in tuberculosis with asthenia, loss of appetite, and the other symptoms of debility already mentioned.

In addition to proper nourishment and fresh air, it has been generally found necessary to administer remedies to counteract these losses. To this end, *iron* in some form is indicated. While many of the newer preparations of iron have been employed during the past generation, the trend of unbiased clinical experience is gradually leading us back to the older officinal preparations, whose value has been established by time and experience—viz., the tincture of the chlorid of iron and carbonate of iron, as contained in Blaud's pills, and the sirup of the iodid of iron. The main point to be borne in mind in the administration of these and other salts of iron is not to give too much, as it then burdens the alimentary tract and causes headache and other disagreeable symptoms.

Next to iron, the reconstructive agent which has for years been valued highly, and which still holds its place, is *arsenic*. This may be administered in the form of arsenious acid—dose for an adult, $\frac{1}{40}$ grain three times daily—or Fowler's solution, beginning with three drops and increasing up to eight drops. Other preparations of arsenic may be employed which meet the approval of the clinician and the demands of the case. Arsenic is apt to produce gastric disturbances and puffing of the cellular tissues beneath the eyes. When these occur the dose must be reduced.

To counteract the debility and improve the nervous tone, no drug takes the place of *strychnin*. The preparation usually employed for this purpose is the sulphate. It may be given in doses ranging from $\frac{1}{60}$ to $\frac{1}{30}$ grain three times daily, or it may be desirable to give it in the form of tincture of nux vomica, from which we get not only the tonic effect of the drug, but its action as a stomachic as well; of this 10 to 15 drops may be given three times daily. When excessive nervousness, muscular tremor, twitching, and high arterial tension are produced, the dose should be reduced or the drug withheld for a time.

Any of the above-mentioned drugs may be given separately or in combination. In appropriate cases the *hypophosphites* will also prove of value. These are commonly administered in the form of compound sirup of hypophosphites (U. S. Phar.) or the more recent glycerophosphates, which are prepared with and without sugar. The doses of these range from one to two teaspoonfuls three times daily.

The clearer our insight into diseased processes becomes the more we find it desirable to confine ourselves to single drugs or simple combinations which meet the particular indication rather than to adminis-

ter a combination of drugs, many of which add an additional load to the already overburdened system of the patient.

Fever.—Fever is an early, prominent, and frequently distressing symptom of tuberculosis. For a time it was thought that the pyrexia was produced by the presence of other organisms (e. g., streptococci, staphylococci, etc.), as these are commonly found associated with the tubercle bacillus; but judging from clinical experience and from the results of administration of tuberculin, we are justified in stating positively that the toxins produced by the tubercle bacillus do produce fever without the presence of other organisms. For the prevention of fever, or to diminish it when present, our remedial agents may be classified under three subdivisions, viz.: (1) *rest* and *food,* (2) *hydrotherapy,* (3) *medicines.*

It has been proved that exercise of body or mind elevates the temperature in tuberculosis. A walk beyond the endurance of the patient, a ride taxing his strength, or any undue physical exercise, has caused a rise of temperature of one or more degrees. On the other hand, distressing news or too much excitement produce the same effect. An improper quality or quantity of food produce a like result, and Cornet lays special emphasis on the fact that, with other elements of error thrown out, the patient's temperature tends to decline the nearer you can bring him to a solid diet.

When the patient's temperature is elevated, it is essential to give him all the bodily and mental rest necessary. If this means keeping him constantly in bed, let it be so. This does not imply, however, that fresh air must be kept from him; quite the contrary. If, from the nature of his surroundings, the patient must keep to his bed, free ventilation of the apartment must be maintained. Change of environment seems to be beneficial and desired by all the animal kingdom, and counts even in matters of small detail. Hence, when possible in these cases, it is effective physically, if no other way, to change the patient from his sleeping bed to a couch or easy chair, from his room to a veranda or lawn, such change being accomplished without exertion or thought on the part of the patient. No one can be shielded from all trouble in this world, still such as may should be kept from the patient and he should not be allowed to receive visitors who tax his energies or who are injudicious in their conversation. It may be stated, generally, that patients whose temperature ranges over 99.5° F. should not only abstain from exercise, but should be confined to bed or to an easy chair until the temperature shall have remained normal for several days. The effectiveness of rest is seen in the improvement which comes from the immobilizing of a tuberculous joint, the checking of the tuberculous lung process by the development of a pleurisy, etc.

When the temperature is not controlled by these procedures, or even along with them, *hydrotherapy* may be employed. The temperature usually rises in the afternoon, except in advanced cases, when it may remain elevated more or less all day; occasionally a reversal of the afternoon rise may occur. When the temperature rises it may be reduced by a hot mustard *foot bath*—two heaping tablespoonfuls of mustard in a foot tub two thirds full of water of a temperature as hot as can be borne comfortably. The feet should be allowed to remain in this until they tingle; the knees are covered with a blanket. Following this, the temperature will often drop, the pulse become quiet, headache (if present) will disappear, and the patient lapse into a tranquil, refreshing sleep.

If the foot bath fails to reduce the temperature, resort to *sponging* may be had; this may be general or include only portions of the body—e. g., the arms, legs, or head. Water of the ordinary temperature is commonly employed, though in cases of high fever ice may be added, or in the debilitated and where the temperature is low the water may be tepid. In the former the effect may be increased by the addition of alcohol or vinegar to the water, in the proportion of 1 part of alcohol or vinegar to 3 or 4 parts of water. Both increase the rapidity of evaporation, and not only remove the excess of heat, but are especially grateful to the patient.

In some cases a *general bath* may be indicated, and in still others the application of an ice-cap.

The employment of *drugs* to reduce the temperature is to be deprecated, and is only to be resorted to when all other measures fail and the temporary condition of the patient seems to demand it; for it must be borne in mind that most drugs used for this purpose are muscle paralyzers and are effective by depressing the heart.

The safest of all drugs is quinin, but it does not belong to the class mentioned. It will sometimes prove efficient, but its antipyretic effect is so slight that it will usually be found to avail little. Of all the coal-tar derivatives, I prefer phenacetin, as I believe it to be the safest. When given in the proportion of phenacetin, 5 grains, citrate of caffein, 1 grain, and camphor monobromate, ½ grain, and not repeated within three hours, I have never observed any unpleasant result. Some authorities give antipyrin, 5 to 10 grains, and Koch believes that pyramidon, not exceeding 30 grains in twenty-four hours, is more beneficial and less depressing than any of the class. Acetanilid I have found to be a dangerous drug, and I do not prescribe it. Aconite and veratrum viride act on the circulation and likewise depress the temperature. They may be employed in cases with high arterial tension.

It is to be constantly borne in mind that in the employment of any

of these antipyretic drugs we are compromising both with the patient and the disease. They add to the immediate and temporary comfort of the patient, but no one claims that they exert any specific effect whatever on the disease. They should, therefore, be employed only at intervals and when all other measures fail.

Cough.—It is essential to understand the physiologic nature of cough in order to treat it. In the absence of some abnormal stimulus, cough does not occur. In its last analysis, cough is nature's effort to free the bronchial tract from some offending stimulus. Just as stimulation of the olfactory ending in the nasal mucosa by means of a feather or by the edematous pressure produced by a "cold" will produce a sneeze, so the stimulation of the laryngeal tract or bronchial mucosa, mechanically or by congestion, will produce a cough. In both instances the process is purposeful. It is an effort to free these passages so that the normal respiratory movements may not be impeded. Again, while coughing has for its immediate object the clearing of the respiratory passages, it is ultimately for the benefit of the body as a whole.

Coughing may likewise occur from other reflex stimuli. A cough results from a mechanical stimulation of an area in the external auditory canal, and similarly the stimulation of the terminal filaments of the vagus nerve in the gastric mucosa may produce a cough, the so-called "stomach cough." Highly nervous patients, even in the absence of all objective causes, will have a dry, hacking cough, which, for the want of a better name, has been styled a nervous cough. Just what produces the peculiar cough characteristic of pertussis we cannot at the present time say; but all of these facts, physiologic and pathologic, teach us that we must, in all cases, endeavor to determine the cause of the cough before we attempt to abate it.

In the course of chronic pulmonary tuberculosis, a certain amount and kind of coughing is not only not injurious, but positively beneficial. When the cough is productive, bringing up, as it often does, quantities of sputum, and when it is not too frequent, it is beneficial in freeing the bronchial tubes of the obstructing mucus and detritus. This is especially true when bronchiectasis is present. A mistake not infrequently made in tuberculosis is to treat the cough rather than the disease. An extreme, it seems, has been reached in the more or less general proscription of cough remedies which contain sugar. Opiates and expectorants are at times demanded, and I fail to see why we should not be allowed to make these palatable by the use of sugar. If sugar must be eliminated because it upsets the digestion, take the sirup from the griddle cakes when you take it from the cough mixture. The writer believes that in a majority of instances it is the expectorant drugs, rather

than the sugar, that derange the digestion; however, there are cases from which sugar should be withdrawn.

In the control of the cough the essential thing is the determination of its cause. If produced by a disordered stomach, attention to the digestion is necessary. An inspection of the external auditory canal is never out of place, though cough produced by a trouble there is exceedingly rare. A very common cause of cough is found in catarrhal and other inflammations of the pharynx and larynx. Such a cough is little influenced by cough remedies unless they contain enough opiate to obtund the sensibilities of the patient. To relieve this cough, treatment of the local condition is essential. (Treatment of laryngeal tuberculosis is purposely omitted here.)

In catarrhal inflammations of the pharynx and larynx, excellent results have been obtained by painting the affected parts once daily with the following:

℞ Potassii iodidi ..... gr. x; 0.66 gm.
Tr. iodini, } āā..... ℥ss; 16.00 "
Glycerini, }
M. Sig.: Apply to throat as directed.

This may be augmented by spraying the throat, *p. r. n.*, with

℞ Mentholi ..... gr. xx; 1.30 gm.
Camphoræ ..... gr. v; 0.33 "
Eucalyptoli ..... gtt. iv; 0.26 "
Ac. carbolici ..... gtt. vj; 0.40 "
Liquid albolene or (glymol) ..... ℥ij; 60.00 "
M. Sig.: Use in atomizer.

When a more germicidal and a stringent effect is desired, some of the silver salts may be employed—e. g., one per cent silver nitrate or five to ten per cent argyrol, applied with a cotton applicator once daily. The additional employment of a spray of Dobell's solution, or some such alkaline antiseptic preparation, *p. r. n.*, will often prove of service.

Naturally, tumors or ulcers on the larynx or epiglottis will require treatment, but these produce a cough that is more or less characteristic.

Leaving out of consideration these extrabronchial factors, we come to the treatment of the cough which commonly forms a part of the history of pulmonary tuberculosis. In the first place, coughing gets to be more or less a matter of habit and is, more than would generally be believed, under control of the will. This is amply demonstrated in all well-conducted sanatoria where, considering the large number of patients in varying stages of the disease, the amount of coughing is exceed-

ingly small. Patients may be educated to suppress the cough when it is not productive. As a routine measure, patients of all kinds, both in and outside of sanatoria, should be taught to favor the cough when material may be raised, to repress it as far as possible when the cough accomplishes nothing. It is surprising how much the cough may be repressed in this way. By avoiding excessive exercise in which respiration is carried on through the mouth, thereby causing undue dryness of the throat, the cough may be lessened. Some patients must be confined to bed so as to avoid all muscular activity.

In like manner, by lessening or leaving off the use of tobacco (especially cigarettes, which are almost universally inhaled) and avoiding alcoholic excesses, the cough resulting from local congestion produced by these habits will be relieved without the use of medicine.

In certain coughs which are more or less irritative, and in which the patient's rest is much disturbed, in addition to the local applications mentioned, I have obtained very gratifying results from the use of an inhaler which covers the mouth and nose. (For ordinary use the Beverly Robinson inhaler, a perforated zinc mask which covers the mouth and nose, in the end of which is a sponge, and which is held in place by elastic strings going round the ears, is commonly employed.)

The following prescription has given much relief:

℞ Mentholi ..... gr. x; 0.66 gm.
Alcoholi,
Creosoti, āā ..... ʒijss; 10.00 "
Chloroformi,

M. Sig.: Put a few drops on the inhaler and use for fifteen minutes, *p. r. n.*

The writer has found this to act well in cases where there is a tendency to hemorrhage. The chloroform lessens the local sensibility, and in diminishing the expulsive efforts of the cough it lessens the tendency to hemorrhage. The patient must be removed from dust-laden atmospheres, those containing irritating gases, and from regions where high winds prevail. In a large percentage of cases many patients will not require internal remedies for the cough, or if so, a glass of hot milk on retiring will suffice. On rising, or immediately after breakfast, coughing paroxysms are frequent. This cough should not be checked, as it serves to remove the secretions which accumulated in the bronchial tubes during sleep; after this the patient ordinarily coughs little, or at infrequent intervals throughout the day. Sometimes the morning cough is sufficient to produce emesis. The emesis is caused by mechanical stimulation of the pharynx by the mucopurulent secretion

brought up, so that when the cough has subsided food should again be taken.

Remedies should be administered for the relief of the cough (1) when it is so incessant and rasping as to disturb the rest of the patient or exhaust his strength, (2) when the cough is tight and the frequent expulsive efforts cannot remove the secretion from the tubes, and (3) when the secretion is excessive and coughing is necessary to free the tubes in order that the respiratory movements may go on properly.

In the first variety the cough is due to a dryness of the throat, trachea, or large bronchi, especially the throat. In this variety the sprays and the inhalations mentioned are of service, or some form of lozenge, or swallowing a bit of vaselin may prove efficacious. Occasionally an anodyne has to be used. For this purpose, heroin, $\frac{1}{24}$ to $\frac{1}{12}$ grain, at bedtime, or repeated two or three times during the day, will prove quite as effective as many of the more complicated cough mixtures.

When the cough is tight and frequent, from inability to raise the expectoration, two demands are to be met on prescribing a cough mixture: first, an opiate to diminish the frequency of the cough, and second an expectorant to loosen the secretion. The vehicle is more or less neutral, so far as its effect is concerned, and there is a tendency to eliminate sugar from it. If sugar or sirup makes the dose more palatable, there is no reason why it should be prohibited, unless it is necessary to eliminate sugar from the dietary.

The following prescriptions are of service in this variety of cough:

℞ Ammonii muriatis ..... ℥iv; 16.00 gm.
Codeinæ sulphatis ..... gr. ij–iv; 0.13–0.26 "
Mist. glycyrrhizæ comp. ..... ℥iv; 120.00 "
M. Sig.: Take in water every three or four hours.

℞ Spiritus ammon. aromatici. ℥ss; 16.00 gm.
Spiritus chloroformi ..... gtt. xlviij–xcvj; 3.16–6.32 "
Heroin ..... gr. j; 0.06 "
Aquæ menth. pip. ..... ℥iij; 90.00 "
M. Sig.: Take in water every three hours.

℞ Morphinæ sulphatis..... gr. j–ij; 0.06–0.13 gm.
Chloroformi ..... gtt. lxiv; 7.60 "
Aquæ camphoræ or menth. pip.. ℥iv; 120.00 "
M. Sig.: One teaspoonful in water every three or four hours.

℞ Heroin ..... gr. j–ij; 0.06–0.13 gm.
Spiritus ammon. aromat. ..... ℥iv; 16.00 "
Aquæ ..... ℥iij; 90.00 "
M. Sig.: One teaspoonful in water every three or four hours.

When the secretion is excessive, an opiate, combined with some agent to diminish the secretion, is indicated—e. g., terpin hydrate, creosote, etc. Heroin with terpin hydrate and codein and creosote, in acceptable vehicles, or in pill form, will yield good results in coughs when the expectoration is profuse. Atropin diminishes all glandular secretion, and for that reason would seem to be applicable here, but in lessening the bronchial secretion it also diminishes the secretion of the glands of the pharynx and larynx and trachea. It produces a dryness that may intensify the cough, so that it must be used guardedly.

Night Sweats.—Night sweats occur with varying degrees of intensity throughout the course of tuberculosis in a large percentage of cases. In some cases they are absent throughout; in others they are slight, transitory, or limited to certain areas of the body; in still others they are excessive, being sufficient to drench the bedclothing and mattress, as well as the clothing of the patient. They occur most frequently at night, hence the name, but may appear at any hour during the day or night. In the milder cases only one severe sweating period occurs; this usually follows the evening rise of temperature and when the first deep sleep takes place. It may occur several times, so that it thoroughly exhausts the patient, becoming a veritable nightmare to him, and in the morning he arises weakened and dejected.

In endeavoring to relieve the condition, the cause producing it must be understood. It should be borne in mind that it is a toxemia—a septic process depending on the absorption of toxins into the blood. These toxins result from the life processes of the tubercle bacillus (?), streptococcus, staphylococcus, and perhaps other organisms; in brief, it is a septicemia. Therefore, it is irrational to treat the sweat. What should be attempted is to try to eliminate the cause of the sweat. In this it is not intended that we should not regard the comfort of the patient and alleviate the condition as far as possible, any more than we would refuse to give an anodyne to relieve the excruciating pain of renal colic on the plea that it is not the pain but the stone that we are after.

From abundant experience, both in private and sanatorium practice, it has been demonstrated that the night sweats will cease in a large percentage of cases by confining the patient absolutely to bed, properly feeding him and giving him the benefit of an abundance of fresh air. These measures, combined with such tonic remedial agents as the individual case requires, will, except in advanced cases, in a comparatively short time bring relief. Until this takes place, and in advanced cases from which nothing may be expected, the sweating must be treated, diminishing it as much as possible and contributing everything to the comfort of the patient. In general and whenever the means of

the patient permit, the clothing of the patient should be removed as soon as it becomes wet, and his body sponged with alcohol and water, or vinegar and water, keeping up a brisk rubbing all the while. Fresh clothing and bedclothes should be provided.

Most of the remedies employed to prevent or diminish the sweat act by controlling the symptom and exert no effect on the causative process. At the same time, these remedies are neither to be condemned nor despised if they contribute to the patient's comfort until the defensive forces of the body are reënforced to the point of defeating the infecting agents. Atropin, in doses of from $\frac{1}{200}$ to $\frac{1}{100}$ grain, is the remedy commonly employed for this purpose, and the one which, on the whole, yields the best results. This may be repeated two or three times in the twenty-four hours, if necessary. Aromatic sulphuric acid, gtt. 10, in water three times daily, and agaricin, $\frac{1}{20}$ grain, are similarly used. They may be employed singly or in combination. All are symptomatic remedies, and their administration should be stopped as soon as the distressing symptom abates.

Gastro-intestinal Disturbances.—Derangements of digestion are a common accompaniment of tuberculosis, and present one of the greatest difficulties in its treatment. Where the digestion is normal, forced feeding is a comparatively easy matter, and where superalimentation and fresh air are possible, the disease is not apt to progress. Unfortunately, the alimentary tract is not always equal to the additional demand and catarrh of the stomach and intestines is relatively common, so that when patients coöperate with the physician and take an excess of food, they are unable to digest it, and it acts as a burden rather than a benefit. In a majority of cases, however, the patient suffers, not because he cannot digest the food, but because his appetite is impaired and he cannot be induced to take it. For this reason, foods which can be swallowed easily and digested readily are usually recommended, such as milk, variously modified, eggs, animal broths, although experience teaches that those patients do best who can take a solid mixed diet.

The digestive disturbances that follow in the wake of tuberculosis do not differ essentially from those which characterize other diseased processes, so that the problems to be solved are similar, except in the case of tuberculous enteritis.

When the appetite fails the digestive stimulants already considered are to be administered. Again, a test meal and examination of the stomach contents will reveal what digestive elements are lacking in this as in any other gastric disorders. When it has been shown that a particular element of the gastric juice is lacking, a restriction of the food, with reference to this, and the supplying of the lacking ingredients should

be attempted. The point to be emphasized is that there is no reason why our therapeutics should differ when gastric disturbances are present in tuberculosis.

Creosote has for a long time been regarded as a remedy for tuberculosis, but as our experience accumulates we are forced to the conclusion that its beneficial effects come from improvement of the digestion rather than from any specific action on the disease. It has been proved, it is true, that the bacilli can be killed by a sufficient amount of creosote, but clinical experience has also shown that a sufficient amount of it cannot be gotten into the circulation to produce any specific effect without deranging the digestion. In proper dosage, however, it produces valuable digestive effects: it causes the dry and glazed tongue to become moist; the appetite improves; the fermentation is lessened. The same holds true in intestinal indigestion. Pure beechwood creosote (gtt. 1–5) is employed, administered either in wine, milk, or capsule, or, what is thought to be less irritating to the stomach, carbonate of guaiacol (5 to 10 grains) or creosotal (5 to 10 grains) may be substituted.

When constipation is present laxatives should be employed, as the comfort of the patient is thereby increased and his nutrition improved. No remedy has been found to supplant sulphate of magnesia or an occasional dose of castor oil. At least one good movement daily should be the rule. When diarrhea is present, its cause should be ascertained if possible; frequently an improved action on the part of the liver will be demanded, and a purge with castor oil or salts will bring about a return to the normal. This, and a proper regulation of the diet, are in most cases all that is necessary. In others, however, the administration of bismuth or tanalbin and opium will be demanded. When fermentation is excessive and undigested food is passing in the stools, aside from the regulation of the food it will be found necessary to give pancreatin (5 grains) with some agent which prevents fermentation, such as salol (5 grains) or guaiacol (5 grains), asafetida (5 grains), which last acts not only in this direction, but also serves as a sedative to the nervous system.

℞ Extr. pancreatis, } āā ..... ʒj; 4 gm.
Sodii benzoatis, }
Asafetida ..... ʒss; 2 "

M. Ft. in caps. ad. No. XII. Sig.: One capsule three times daily.

These and other agents which will appeal to the individual practitioner may be employed with or without the addition of opium. Charcoal, by its mechanical action in absorbing many times its volume of gas, is highly recommended by some. When the accumulation of

gas is great, it produces much bodily discomfort and mental distress, not only by its mechanical pressure on the heart and lungs, but by its absorption. In this condition a brisk cathartic is indicated and immediate relief may be obtained by an asafetida enema of tincture of asafetida, and warm water. The effect of this is enhanced by giving it through a rectal tube, and after its use, if the gaseous distention still is great, the rectal tube may be inserted and left in place for several hours. Of course this effect is only temporary, but it at times means much to the patient's bodily comfort and relieves his mind.

Hemorrhage.—Of all the symptoms of tuberculosis, hemorrhage is, perhaps, the most alarming to the patient and his friends. The abject terror and demoralization on the part of the patient is due to the fact that it is not infrequently the first flat argument that he has tuberculosis, and, again, the source of the hemorrhage makes it plain to the average patient that not only he, but his physician, are, in a sense, at its mercy. Fortunately, no incipient and few advanced cases of tuberculosis die from the immediate effects of hemorrhage. Before cavity formation the hemorrhage is bronchial. After this it comes from the erosion of a blood-vessel or the bursting of an aneurysm; the result will depend on the size of the vessel that ruptures. Considering the prevalence of tuberculosis and its destructive process in the lungs, it is singular that so few patients die from hemorrhage. In rare cases, with enormous cavities, patients have been known to bleed to death with little or no blood appearing in the expectoration.

In cases of pulmonary hemorrhage my practice is uniform, and no information which our present methods of physical examination give is sufficient to make me change it, for the very good reason that we have no means of telling, aside from the amount of blood that comes up, the size of the vessel that has ruptured. I have seen a patient who had a cavity apparently no larger than a walnut practically exsanguinated by the excessive loss of blood. On the other hand, in cases with enormous cavities, the hemorrhage is oftentimes small. There is, then, no infallible index, and when the hemorrhage is taking place, even the source is immaterial, for whatever its source, outside of strapping the chest to restrict its movements the indications for treatment are the same.

These consist of the following: Absolute rest in bed, with the body elevated by pillows so as to let gravity act as little as possible. The patient should make no active exertion whatever. If the hemorrhage is excessive the blood should be caught by an attendant, who holds a basin under the chin of the patient. After this, when the hemorrhage is less active, the blood should be caught in a cloth, but the patient should not have to do this for himself. His position in bed

should be changed as little as possible, and he, of course, should not be allowed to talk or rise from his bed, even to attend to the wants of nature. It is a safe plan to keep all patients in bed for at least three days after the hemorrhage, and even then exercise should be resumed very gradually.

Aside from the imposition of absolute and immediate rest, the first indication on the appearance of a hemorrhage is a hypodermic injection of morphin. I usually give ¼ grain, as I believe that ordinarily less does not accomplish the purpose. In those cases in which this amount causes the blood accumulation to strangle the patient, as is claimed by some, I believe that, if left to flow freely, it will more quickly exsanguinate him. In other words, I believe that our only hope in pulmonary hemorrhage is the clotting of the blood so as to heal up the broken vessel by pressure. Morphin effects this by quieting the respiratory movements, checking the cough and obtunding the sensibilities of the patient. It is perfectly legitimate to argue that the hemorrhage may be of such a degree as to drown the patient in his own blood if it is pent up in the lungs; on the other hand, it seems to me to be equally true, in the first place, that a hypodermic of morphin which does not put the patient into a stupor is not going to accomplish this, and in the second place, if the flow is not checked by a certain amount of retention of blood, the patient will surely bleed to death. The morphin also steadies and acts as a tonic to the heart. It goes without saying that the dose of morphin must be regulated by the age, size, physical condition and idiosyncrasies of the patient. It should be repeated sufficiently often to control his cough and nervous perturbation.

After the immediate demands are met, the same effects may be obtained by the administration of appropriate doses of heroin, codein, or morphin by the mouth. However, it is preferable to abstain from any medication that is apt to upset the stomach, as emesis would tend to increase or renew the hemorrhage. It is well also not to attempt to give any solid food for twenty-four hours. If the hemorrhage has been severe, an enema of salt solution or a hypodermoclysis will produce a more immediate effect than food introduced, often through protest and with difficulty into the stomach.

There can, of course, be no objection to giving egg albumen in the water that is often craved in large quantities. Milk may be given in place of water. It is common for patients having a hemorrhage, from such information as they may have, or on the advice of solicitous friends, to eat salt. It serves to occupy the attention of the patient, but its effect on the hemorrhage is infinitesimal, while by deranging the stomach it may cause vomiting, which, as has already been stated, is bad.

From its effect in uterine hemorrhage ergot has been employed as

a routine practice in pulmonary hemorrhage. Confidence in it, with added experience, is wavering. I have never seen it accomplish any good whatever in pulmonary hemorrhage, and, indeed, some observers claim that it does harm. What applies to ergot applies with equal force to its preparations, ergotin and ergotole. It is probably also true that tannic and gallic acid not only fail to do good, but serve to derange the stomach.

From a scientific standpoint calcium chlorid, by increasing the coagulative power of the blood, would seem a rational remedy to use. It may be given in doses of 5 to 15 grains, three or four times a day. It should be used more generally and its effects more carefully noted. Gelatin has been employed in somewhat the same way in an effort to increase the coagulability of the blood.

From a purely empyric standpoint, perhaps, some of the preparations of the suprarenal body are being used as remedies in pulmonary hemorrhage. For the past four or five years I have employed them, along with opium, in all my cases of pulmonary hemorrhage. It may be difficult to explain from a physiologic standpoint just how it may be expected to control hemorrhage from the pulmonary vessels. In the absence of a satisfactory explanation, my experience still leads me to rely on it in this condition. I usually employ 5 drops of adrenalin chlorid, or 3 grains of the suprarenal extract, every three or four hours, while the hemorrhage persists or the sputum is bloody.

So far as we know, adrenalin inhibits hemorrhage by vasoconstriction. It is proved that it increases vascular tension by its vasoconstriction effect. If we had only this evidence we would not use it even in epistaxis, as by increasing the pressure in the blood-vessels it gives additional power to wash away any clots that might form to seal up the vessels. Clinically, however, we know that it is the most reliable medicinal agent we possess for checking hemorrhage, with the possible exception of the perchlorid of iron, and this is rarely, if ever, employed because of its disagreeable local effect.

If the extract of the suprarenal gland controls hemorrhage that is accessible, it may have the same effect also on that which is not. In any event, it is recommended in cases of hemorrhage in typhoid and in uterine hemorrhage, and I see no reason why, if it acts well in these cases, it should not also be efficient in pulmonary hemorrhage.

From a physiologic standpoint, the nitrites have a diametrically opposite action, producing vasodilation. They diminish intra-arterial tension. This produces less pressure on the break in the vascular mechanism and allows the coagulum more quickly to close the opening. This has led to the use of nitrite of amyl, which, because of its diffusibility, is usually dispensed in glass globules, one of which may be

broken in a handkerchief and inhaled as occasion demands. More commonly nitroglycerin is used, either hypodermically when the hemorrhage is taking place, or by mouth to prevent its recurrence. The dose ranges from $\frac{1}{100}$ to $\frac{1}{50}$ grain, repeated as occasion demands. When undue flushing of the face and headache result, it is the signal that the dose should be diminished or the drug withheld. N. A. Johnson and R. H. Babcock recommend hypodermics of atropin immediately on the appearance of the hemorrhage, in doses of $\frac{1}{50}$ to $\frac{1}{25}$ grain.

When the intravascular pressure is great, the pulse rapid and bounding, and a marked accentuation of the second heart sound exists, nitroglycerin may be employed. Flick believes that it not only diminishes hemorrhage, but that it prevents the development of hemorrhage. In extreme conditions $\frac{1}{100}$ grain every two hours may be given. Nitroglycerin possesses two advantages that should be considered. It lowers arterial tension and increases the secretion of urine. Sodium nitrite (3 to 5 grains) three or four times a day may be substituted for nitroglycerin, and is said to have a more permanent effect.

The vascular system may be depleted by the exhibition of salts. Their employment is indicated for the same reason as are the nitrites, but their action is not so immediate and the additional drawback to their use is found in the exertion which active purgation enforces on the patient. While salts may be rationally employed after the hemorrhage has abated, I rarely prescribe them inside of twenty-four hours of an active hemorrhage.

I speak lastly of the application of the ice-bag, because, as already mentioned, the source of the hemorrhage is not always accurately known, and while the hemorrhage is taking place it is unwise to try to find it; and to be more than generous in our estimate, it is of questionable value. It quiets the tumultuous activity of the heart, and in so far may do good, but I do not believe that it has any effect on the bleeding vessels. If it is of such questionable benefit, and the same results may be obtained by other more promising measures, I see no good reason for its employment.

When the hemorrhage is excessive the emergency may be tided over, and the patient's life sometimes saved by keeping the blood in the extremities by means of a constricting band of rubber tubing or other form of tourniquet; these should be released successively so as to let the blood into the general circulation and to avoid the formation of clot and subsequent gangrene of the extremities. In extreme cases the elevation of the foot of the bed and hypodermoclysis may be necessary.

Cardiac Weakness and Dyspnea.—The destructive metamorphosis which is general throughout the musculature of the body is also present in the heart; the heart muscle gets weak and flabby and dyspnea be-

comes a distressing symptom. In addition to the general and cardiac muscular weakness in producing dyspnea, we must also consider the effect produced by the destruction of lung tissue and the toxic effect of the poisons absorbed. The last is well illustrated in the dyspnea that accompanies excessively high fever. In combating the condition which is at times most distressing, one should look to two ends, viz.: the general treatment of the underlying condition which is producing the trouble, and the immediate alleviation of the urgent symptoms. Graduated massage and exercise, an abundance of food and fresh air will, by improving the general condition, alleviate some cases, but the majority of cases require absolute rest in bed.

In this condition strychnin is almost always indicated, and it may be given in larger doses than are ordinarily employed. Tincture of digitalis (gtt. 15) three times daily or every four hours is a remedy of the greatest value. Alcohol in generous quantities should be administered. The rapidly diffusible stimulants, such as aromatic spirits of ammonia, Hoffman's anodyne, or a solution of camphor in oil, either by mouth or hypodermically, may be employed in appropriate cases.

In some cases the inhalation of oxygen gas will give the greatest temporary relief. Finally, when the dyspnea is excessive and the distress of the patient great, the effect of the hypodermic injection of $\frac{1}{4}$ grain of morphin is almost magical. Considering the amount of lung tissue destroyed and the toxic processes at work, it is singular that we do not have this distressing symptom oftener.

COMPLICATIONS

The more common complications of tuberculosis are pneumonia, insomnia, pain, pleurisy, both with and without effusion, empyema, pneumothorax, pityriasis versicolor, ischiorectal abscess, and *fistula in ano*. The treatment of pneumonia complicating tuberculosis does not differ from that complicating other diseases.

Insomnia.—In dealing with insomnia in tuberculous patients, the same rule should guide us as in treating the proper symptoms of the trouble, give as little medicine as possible. In some cases allaying the cough, or in others checking the night sweats, may do away with the insomnia. A glass of hot milk taken at bedtime, or milk to which whisky or cognac brandy has been added, will make the patient fall into a tranquil sleep.

When drugs must be employed, those which disturb digestion least should be used. I have found veronal, trional, and sulphonal to fulfill this condition and to produce a sleep more closely akin to nature's sleep than any other hypnotics. Veronal is usually given in 5-grain doses

in capsule. Trional and sulphonal are best administered in a powder or cachet. Ten to 15 grains are usually given at a dose, and should immediately be followed by a cupful of milk or water, as hot as can comfortably be swallowed. This hastens and increases the effect of the drug. In cases with much nervous disturbance I have found the following prescription especially efficacious, particularly when there is present, in addition, the so-called nervous cough:

℞ Sodii bromidi ..... ℥j; 30 gm.
Spiritus ammonii aromatici, } āā..... ℥ss; 15 "
Spiritus lavandulæ comp., }
Essence pepsini ..... ℥iv; 120 "
M. Sig.: One drachm to two drachms in water at bedtime.

Instead of the above, chloralamid (10 grains) may be administered on retiring. Naturally opium, in some of its preparations, or cannabis indica will produce the same result, but they should only be given when the other remedies mentioned have failed.

Pain.—When pain in the chest occurs in tuberculosis, its cause should be sought for and ascertained. The treatment of muscular pains and neuralgias does not differ essentially from that employed in other diseases. When the pain is pleuritic, it may be alleviated by external applications—e. g., mustard plasters, tincture of iodin, dry cupping, etc., over the affected area, or hot-water stupes, poultices, hot-oil compresses, etc. In a majority of cases, strapping the chest on the affected side with strips of adhesive plaster will, by limiting the respiratory excursions, bring relief. In some cases it will be found advisable to administer sodium salicylate (5 to 10 grains) three times daily, or phenacetin (5 grains) repeated in three or four hours, if necessary. Occasionally a hypodermic of morphin (¼ grain) or codein (½ grain) may be necessary.

Pleurisy with Effusion.—When there is pleurisy with effusion, when the fluid accumulation is sufficient, the pleuritic pains subside spontaneously. In order to get rid of the exudate, the amount of fluid ingested should be cut down to the minimum, and the activity of the kidneys increased. For this purpose nitroglycerin ($\frac{1}{100}$ to $\frac{1}{50}$ grain) and infusion of digitalis (℥ss) every four hours may be given; or it may be necessary to add to the above acetate of potassium or sodium (20 to 30 grains), the object being to make the amount of liquid excreted greater than that which is drunk.

If this cannot be done, then resort must be had to the aspirating needle. If paracentesis of the thorax is undertaken it should be done under the strictest aseptic precautions, otherwise a serous pleurisy will be converted into a purulent pleurisy.

In performing paracentesis the skin should be cleansed thoroughly with green soap, alcohol, and ether at the point where the needle is to be inserted, which should be between the eighth and ninth ribs, in a line with the angle of the scapula, or in the seventh interspace, in the midaxillary line. The needle should be thoroughly sterilized by boiling, and should be inserted close to the margin of the lower rib, as in this way one will avoid wounding the intercostal artery which runs in the groove beneath the rib above.

Local anesthesia of the part may be obtained, if desired, by the hypodermic use of cocain, by freezing the area either with an ethyl chlorid spray or by the application of ice. The intercostal space may be widened by placing the hand of the affected side on the opposite shoulder. The fluid may be withdrawn simply with a needle, to which a long tube is attached, thus siphoning it off, or the tube may be attached to a bottle in which a partial vacuum is produced by a pump and the fluid thus sucked out. In large effusions too much fluid should not be withdrawn at one time, as the too sudden removal of pressure on the heart and vessels has led to serious consequences. When the patient complains much of faintness, or violent coughing ensues, it is well to desist.

After withdrawing the needle the aperture in the skin should immediately be closed by a strip of adhesive plaster.

Empyema.—In the case of empyema the pus should be removed as soon as the diagnosis is made. In the majority of cases this may be effected by making a free incision in the midaxillary line between the sixth and seventh ribs and introducing a drainage-tube. In some cases the space between the ribs is too narrow to admit a drainage-tube of sufficient size. Then two or more ribs must be resected (Estlander's operation).

Pneumothorax.—In pneumothorax, rest in bed and strapping the chest are to be recommended. Stimulants will be necessary when faintness and collapse are present. When much coughing and dyspnea occur, a hypodermic of morphin ($\frac{1}{4}$ grain) is indicated.

Pityriasis versicolor.—Pityriasis versicolor is a harmless though troublesome symptom which occurs in tuberculosis. It may be distributed, more or less, over the entire body, the spots and bleblike elevations varying in size from a small shot to a split pea. It may readily be relieved by washing the skin with castile soap and warm water, sponging in vinegar or dilute acetic acid, and afterwards with a drachm of sodium hyposulphite to the ounce of water. Three applications of this, according to Latham, are usually sufficient.

Ischiorectal Abscess.—Ischiorectal abscess occurs not infrequently in advanced stages of the disease as does also its companion, *fistula in ano*. The treatment is entirely surgical.

Tuberculous Laryngitis.—Tuberculous involvement of the larynx and epiglottis is one of the most serious and at the same time distressing complications of tuberculosis. For its relief the same general régime of fresh air, feeding, rest, etc., is demanded. In addition, local treatment of the affected area must be carried out. Nowhere is the effectiveness of rest better proved than here. The patient should not be allowed to talk at all; even loud whispering is to be avoided. In making his wants known the deaf and dumb sign language or a writing tablet should be used.

As a local application, a ten-per-cent solution of argyrol may be applied to the vocal chords once daily or they may be painted with a solution of equal parts of tincture of iodin and glycerin, to which ten grains of potassium iodid have been added. Much relief will also be afforded by the use of the following oil spray, the patient taking deep inhalations the while:

℞ Mentholi	gr. xx;	1.33 gm.
Camphoræ	gr. v;	0.33 "
Acidi carbolici	gr. vj;	0.40 "
Eucalyptoli	gtt. iij;	0.20 "
Glymoli	℥ij;	60.00 "

M. Sig.: Use in atomizer, *p. r. n.*

When ulceration of the chords exists, Heryng and Krause recommend painting or gentle rubbing of the ulcers with lactic acid, 30 to 80 per cent, once or twice a day, if too great distress is not caused; or Lake's pigment (lactic acid, 50 per cent; formalin, 7 per cent; carbolic acid, 10 per cent). Deeper ulcers require curettement and electrolysis. Insufflations of iodol, aristol, and orthoform are also employed. Prior to the application of these, it is frequently desirable to cleanse the parts with an antiseptic spray—e. g., Dobell's solution.

If much edema of the glottis exists, scarification may give some relief. In this condition the writer has gotten satisfactory results from the application of suprarenal extract with chloretone or adrenalin chlorid. It acts in the same way here as it does in opening up a nose that is closed by a congested mucous membrane. It has not the anesthetic properties of cocain, but it possesses two advantages that cocain has not —its effects last longer by several hours, and in addition it does not derange the digestion. In severe cases it may even be combined with cocain.

When the ulceration is marked and the edema great, the patient reaches a point where proper nourishment is a serious matter, not only on account of the difficulty in swallowing, but also because of the pain

and because the swollen and enlarged epiglottis does not close down properly, thus allowing food to go into the trachea, causing violent coughing and suffocation. By painting the area with suprarenal extract and following this, if necessary, by the application of a four-per-cent solution of cocain, much comfort will be given the patient and he will more readily take the necessary amount of food.

Sometimes his food will have to be administered through a stomach-tube, and in some cases even the passage of the stomach-tube is intolerable, and resort will have to be had to rectal feeding.

In extreme cases, with marked dyspnea, tracheotomy will have to be performed.

Diarrhea.—Diarrhea occurring in the course of tuberculosis may be the result of indiscretions in diet, of irritation by foodstuffs, which, though not of necessity indigestible, still from impaired digestive activity are not assimilated, act as irritants to the digestive tract. On the other hand, the diarrhea may arise from tuberculous ulceration of the intestine. The latter necessarily causes the greater difficulties, and at times is utterly beyond our control. In either case it is best to rid the alimentary tract of any indigestible food residue that may be present. For this purpose it is well to give calomel in ¼-grain doses every half hour until 2 or 3 grains are taken. This should be followed by a brisk saline laxative, or, in some cases, castor oil. Naturally, the diet must be regulated and only such food as is easily digested should be allowed. Bismuth should be given in some form, either the subnitrate (30 to 60 grains), the subgallate (10 grains), or the salicylate (5 grains), every four or six hours, with opium, either the powdered extract (¼ to ½ grain), codein (½ grain), paregoric (1 to 2 drachms), or Dover's powder (3 to 5 grains), and repeated as occasion demands. In some cases tannalbin (10 to 15 grains) will be of service.

When the discharges are excessive I have obtained good results from bismuth.

℞ Tincture catechu comp.,
Tincture opii,
Spiritus camphoræ, āā..... ʒijss; 10 gm.
M. Sig.: 30 to 40 drops every four hours.

Francine recommends the following, as modified from Osler:

℞ Plumbi acetatis ..... ʒj; 4 gm.
Acidi acetici dil. ..... ʒjss; 6 "
Syrupi simplicis ..... ʒiij; 12 "
Aqua cinnamoni .....ad ʒiij; 90 "
M. Sig.: A teaspoonful three or four times a day.

THE SANATORIUM, ITS CONSTRUCTION AND MANAGEMENT

By ARNOLD C. KLEBS

In the foregoing paragraphs the hygienic treatment of tuberculosis has been discussed without particular reference to special institutions, wherein its details have been elaborated. Although these details are perhaps not of distinct interest to the general practitioner, they cannot fail to be suggestive in many ways, and particularly to those who are contemplating, as seems most desirable, the erection of smaller sanatoria throughout the country.

The term "sanatorium" (*sanare*, to heal) presupposes the curability of the patients whom it is destined to receive. It is not merely a "sanitarium" (*sanitas*, health), a health resort, an institution for the reception of the sick, no matter what their chances for cure. This refinement of terminology is perhaps somewhat artificial, but the tendency of late years has been to call sanatoria those institutions which admit for treatment only patients in the early stages of the disease, in contradistinction to the hospitals which are open to any class of cases.

At one time, especially through the influence of German propaganda, the sanatorium occupied the center of the stage in antituberculosis efforts. For the individual as well as for the State all hope was concentrated in the erection of such institutions. A clearer conception of its true position, through a more precise application of experience, has been gained of late. First of all it has been realized that in order to accomplish a complete and lasting cure a longer sojourn of patients in the sanatorium than customary (three to four months) is necessary, and on the other hand that this longer sojourn has disadvantages in itself, in so far as it very often mentally disables the discharged patient for his former pursuits. Considerations of this kind have called forth of late unnecessarily violent attacks against the sanatorium (Cornet, '07), disclaiming all its merits, at least for the treatment of persons of slender means. That such wholesale condemnation goes too far can be easily demonstrated, and, in explanation of it, it can only be said that it is directed more against a special system as practiced in Germany, than against the principle itself of treatment in closed institutions. But this fight, pro and con sanatoria, has brought forth object lessons which those who are planning the construction of sanatoria will do well to examine more closely.

Brehmer, in Görbersdorf, and later his pupil, Dettweiler, in Falkenstein, by demonstrating the curability of tuberculosis by means of statistics of cases treated by hygienic-dietetic methods in their institu-

tions, started not only an era of greater hopefulness in phthisio-therapeutics, but elevated the method itself to the position it now maintains. There was nothing particularly new in the method; as early pioneers in it must be named Andrew Stewart, of Erskine, Scotland (1747), William Buchan (1783), our own Benjamin Rush (1794), and especially George Bodington, of Sutton Coldfield, Warwickshire, England, who had practiced it successfully before Brehmer and Dettweiler, but the credit for systematic application on a large scale and demonstration of the results, followed by a more general adoption, cannot be denied them. Typical of the German system, as we may call it, is the minute and individual application of hygienic principles under close and persistent supervision of the physician in an especially constructed institution. They were regarded more as schools of hygienic discipline, with little left to the patient's initiative except strict obedience. Differences in national traits have long hindered the introduction of the system into other countries or have brought about modifications. Its paramount value as exemplified by its good results, has spread the sanatorium gospel all over the world, and although it cannot be said to have everywhere the same meaning as to details, its range of activity and its position among other curative agencies, as well as its limitations, are pretty well realized. It is, however, becoming more and more apparent that the sanatorium in its present stage of evolution does not fulfill all the desiderata of institutional treatment, that it needs to be supplemented by other institutions and amplified in its scope; also that the home treatment on sanatorium lines allows perfections not thought possible only a few years ago. If credit must be given to the great Germans, Brehmer and Dettweiler, for having successfully launched the systematic, hygienic, and dietetic treatment in institutions, the elaboration of it has been done in other countries, particularly in England and America. The greatest impetus to English sanatorium evolution, however, came from another German, Walther, who in his Nordrach colony in the Black Forest practiced the method on lines more sympathetic to an English public than those of Goerbersdorf and Falkenstein. In our own country, Edward Trudeau is the undisputed pioneer and leader in sanatorium work. Since 1873, when he was sent to the Adirondack Mountains as a patient, he evolved there, stage by stage, one of the most admirable centers for the treatment of tuberculosis on hygienic-dietetic lines, and one which has been for a long time the sole inspiration for similar enterprises on this side of the Atlantic.

Requisites of the Sanatorium.—An absolute and definite standard of requisites for a sanatorium cannot be laid down. Sanatoria have been constructed in all kinds of climates, after plans differing in many details and at an expenditure varying from a few hundred dollars per

bed to several thousand dollars. In location and in construction the sanatorium has to adapt itself to individual requirements, the financial resources and the number of patients it is to receive. The vast majority of candidates for the sanatorium, however, belong to a class which has to consider carefully every item of expenditure, particularly so in a disease of so chronic a course, which is bound to make heavy demands on all available resources for a long time to come. It is an important duty of the family physician to impress this fact upon his patients and not allow them to stake their last penny upon this one card, the sanatorium, in the belief that the regained health after a few months' treatment will permit their resuming without restraint their former occupation. Future sacrifices will be absolutely necessary in most cases to maintain the improvement made. It is also evident that a multiplication of sanatoria is most desirable. Especially in this country, sanatorium treatment for those classes most in need of it is wholly inadequate. In Germany, where, very largely through the provision of an invalidity insurance system, large funds are available for the building and maintenance of sanatoria, such a multiplication has been distinctly furthered. We have no such system and are chiefly dependent on individual resources, charitable aid, and to some extent on State and municipal initiative. The various State sanatoria now in operation in this country have given a distinct impetus to the movement and it is much to be hoped that municipalities will also awaken to the exigencies of the situation and provide sanatoria for the numerous sick, which cannot find admittance in the State institutions.

If a general standard cannot be laid down for sanatoria and is not even desirable, as was well pointed out recently by Bulstrode ('08), because of its hampering individual experiments, certain definite guiding principles ought to be before those interested in the construction of sanatoria. They ought to embrace selection of a site, constructive planning, and management of the sanatorium.

Before entering more in detail upon these features it may be well to point out that the results obtained in a sanatorium are in no way in proportion to the expense of the institutions. Excellent results can be achieved in an institution providing only the barest comforts; often better ones than in a most luxuriously equipped sanatorium. Results do not depend on elaborate equipment, but on the way in which everything is utilized to improve mentally and physically the condition of the patient. From this point of view elaborateness of equipment, even if to some extent only fulfilling many of the so-called modern sanitary requirements, is often rather hampering than furthering the purposes of a sanatorium. The "infinite number of discontented beings" who, according to Cornet ('07), return from comfortable sanatoria to poor

domestic surroundings, could be considerably lessened by adhering rigidly to the fundamental principle of extreme simplicity in sanatorium construction. This answers the question often asked, whether one shall build cheaply and temporarily, or expensively and permanently.

Selection of Sanatorium Site.—Removal of the patient from the usual indoor existence in a town home to the outdoor life in the country sanatorium constitutes in a sense a change of climate sufficient for the vast majority. The choice of a climate, in the common and wider sense, can be guided by considerations discussed in another chapter. For most patients it is preferable and advantageous that the site be not too far removed from their home and the field of their active ties. Comparative statistics of results obtained in sanatoria in mountain and lowland regions, for instance, differ not sufficiently to form a material basis for the contention, formerly very prevalent, that the sanatorium ought to be situated in the mountains or some other distant region, with alleged climatic advantages. The evident advantage of easier accessibility, better and cheaper food supply from city markets in sanatoria near home, is enhanced by the frequent observation that patients sent to a greater distance and to radically different climatic conditions, though doing exceedingly well while there, often relapse more quickly and hopelessly upon their return.

There is hardly any town or city in the temperate zone in which we live in the neighborhood of which land cannot be procured with all the essential requirements of a sanatorium site. These are, briefly: (1) A *dry soil,* covered with grass; (2) *a cheerful, pleasant landscape*; (3) *absence of smoke- and noise-producing* enterprises; and (4) *accessibility.* Many other requirements are theoretically elaborated in textbooks, but for practical purposes hardly merit mention. Important here, as in any institution for the reception of patients, is, of course, an abundant pure water supply and facilities for proper sewage disposal. Protection against winds, very strongly demanded by some authors for the site, should be noted. It is here purposely left out as one of the essential requirements of a sanatorium site because protection against wind can be provided artificially by the planting of trees and shrubs or shelters built of wood or other material. The absence of natural shelters alone should not discourage the selection of a site otherwise satisfactory. It must also not be forgotten that stagnant air is most objectionable, and often to be found in sanatoria the site of which was selected with too great regard for protection against wind. As said before, artificial shelters can be found against winds, especially in winter, when most objectionable; and, on the other hand, refreshing breezes may be most welcome in a hot summer, it being a common experience

in sanatoria that even excessive cold is well borne by most patients, while excessive heat always affects them badly.

Dryness of the soil is of considerable importance, and merits careful examination before deciding on a site. A determination of the average level of the soil water ought to be undertaken always if the grounds are on level land. This level is usually low on sloping grounds, and for that reason alone a slope will merit preference even if the quality of the soil itself is otherwise imperfect. Given a low level of the soil water, not only on the immediate site of the building but also on the surrounding land (avoidance of marshy and swampy regions), a more or less impervious clay soil, if no other can be found, may be chosen, because the water will run off and leave the surface dry. That the larger part of the grounds be covered with grass is most desirable, because thereby the formation of dust will be prevented to a large extent. It also forms one factor in the next important requirement, the *cheerfulness of the landscape*. This point ought always to merit attention, because there are but few patients who are not sooner or later affected by it. Beautiful scenery is but rarely to be found in the neighborhood of centers where sanatoria are needed, but the open country, wherever it may be, offers choices of sites which can be considered from this viewpoint, although with more modest pretensions. A sloping, undulating, or hilly ground, also, in this regard, will be more desirable than a level one. Meadows, shrubs, and trees add considerably to the cheerfulness of the landscape. Pine-tree regions have for a long time been considered to offer especially desirable sites for sanatoria. A pine forest provides, indeed, a very good shelter, and the soil on which the trees grow usually fulfills the requirement of dryness. Where natural beauty is scant, much can be done toward the artificial improvement of the grounds in this respect, and a selection of a site in a bare country can often be made with this in view. At any rate, this point must merit a great deal more attention that it has often received.

Absence of smoke is the next essential. It means pure, open air. A few miles away from the outskirts of any city such air can be found, and if a greater distance seems desirable, it should be more for reason of the inexpensiveness of land, greater natural beauty, than for the fear that occasionally a few clouds of city smoke will sweep the grounds. Coal smoke is certainly less harmful than fine, irritating street dust; but where it is found, there are usually also other contaminations of the atmosphere from the same sources where it originated. The immediate proximity of railroads, of highroads, and of factories also should be avoided on account of their smoke, dust, and noise.

Accessibility of the site is another desideratum which merits attention. Electric rural lines are being multiplied rapidly nowadays in

the vicinity of cities, and form a very satisfactory means of transportation to and from the sanatorium. Accessibility is also to be considered because of the necessity of a prompt supply of fresh provisions to the institution. But the desideratum of accessibility must not outweigh that of rural surroundings and sufficient remoteness from town life and its temptations. The sanatorium and its grounds ought to form a small colony by itself, where the inmates are busy getting well, an occupation which ought to be rendered not only useful to them, but also interesting.

This can be much enhanced by appropriate outdoor life, and especially by provisions for useful occupation. The question of the *size of sanatorium grounds* has therefore to be considered. Existing sanatoria are mostly provided with ample grounds up to several hundred acres. The size of these institutions and the cost of land will, of course, set a limit. It can only be stated that a sanatorium without ample grounds under its control cannot properly fulfill its objects, as they are nowadays understood. Provision for systematic outdoor occupation is of essential importance to the future welfare of the patients, and it cannot be obtained on cramped grounds. The institution which through rest treatment in the open-air galleries and occasional walks and overfeeding alone accomplishes the famous ninety per cent of cures on dismissal is doing work for the "galleries," but not for the patients, and especially not for their future. This is well substantiated by the after-results in patients treated in German sanatoria by this method (Klebs, A. C., '07).

It cannot be urged too much, not only that the grounds be ample, but also that they be chosen with the prospective of serving directly toward the occupation of the patients, particularly as regards gardening, path-making, etc., as well as for their diversion by certain games, walks, etc.

Planning and Construction.—After the essential requirements with regard to the nature and size of the grounds have been fulfilled, the planning proper of the sanatorium buildings is comparatively simple, although technically more complex. Individual circumstances will have to govern the procedure in each case. An already existing building sometimes will have to be, and can suitably be, altered and utilized for a sanatorium, or administrative purposes, in the latter case the patients being accommodated in separate buildings or shacks. Thus evolved what is usually termed the cottage type of sanatorium characteristic of the sanatoria in this country, modeled after the Adirondack Cottage Sanatorium. This type does not show any purposeful planning, as is sometimes thought. It adapted itself merely to existing conditions, gradually increasing its capacity by additions of new cottages. The type having once become established, and with satisfactory curative re-

sults, the advantages of it and the one-building plan have frequently been discussed with considerable feeling by the advocates of the two types. It is desirable to set aside prejudices in regard to this subject, because *au fond* the differences of the two types are of slight importance.

There have to be two distinct departments in every sanatorium: (1) *Administrative*, including dining room, kitchen, day rooms, etc.; the central heating, lighting, and water plant, as well as the laundry, will in very large institutions form a separate machinery department. (2) *Sleeping accommodations* for the patients. The difference between the cottage and the one-building type of sanatorium resolves itself into the two departments being structurally separate or connected. From the plan which provides one separate administration building with one or more independent patients' cottages to the building which under one roof contains all the departments, various transitional types can be seen in existing sanatoria. A connecting and covered gallery between the patients' quarters and the main building is gradually shortened, and narrow wings, with patients' rooms, radiate from a central building, more or less directly accessible from it. In a larger sanatorium a closer structural connection of the departments facilitates the medical supervision and discipline, reduces the difficulties of cleaning and service, but does not allow a very desirable segregation of patients into groups, according to their congeniality and the stage of the disease, especially in buildings of more than two stories. For this reason alone higher buildings, as so often erected in Germany for sanatorium purposes, do not recommend themselves, although it matters but little how many stories are provided for the administration building.

From the foregoing is seen that it is of but little consequence what type of building plan is adopted, but in *constructive detail* certain prime requisites must be fulfilled. For their discussion we may suitably separate the two principal parts of the sanatorium.

The Patients' Quarters.—Abundant ventilation is here, of course, of first importance. The requirements in this respect cannot be fixed, as is customarily done in hospital buildings, by a certain cubic space per bed. Ventilation does not necessarily improve with the size of an inclosed space, but is dependent on the amount of fresh air supplied, which obviously can be lacking in a large room, while amply provided for in a small one. Mechanical ventilation systems, intended to renew the air by propulsion or traction, are of no use in a sanatorium; they may have some usefulness in the administrative part of a very large institution. In the patients' quarters, however, it is best to rely entirely on ventilation through windows, or, better still, by leaving one wall of the bedroom out entirely. This latter plan has been employed in

this country, and its practicability was first demonstrated by Dr. Millet, of Brockton, Mass., for small individual shacks, and by Dr. H. M. King at the Loomis Sanatorium, Liberty, N. Y., for small wards (ten and more patients). King's "lean-to" introduced one exceedingly important feature, and one which was bound to assure it great popularity—i. e., the addition to the "open-air ward" of a heatable dressing room, with bath and toilet appliances. The principle of the King lean-to has been copied and modified practically everywhere in this country, and fully merits a still wider application. In England of late a similar plan has been followed in some sanatoria (Frimley), and a report made by the writer at the International Tuberculosis Conference at The Hague (Klebs, A. C., '06) has served toward its introduction on the Continent.

The ideal sleeping unit, as at present evolved, can therefore be said to consist of a shelter offering protection against heat and the weather;

Fig. 156.—Dr. Millet's New Modified Shack for One Patient at Brockton, Mass.

above and below, and on two, preferably opposite, sides a heatable dressing and toilet room should be easily accessible from it. The two opposite walls can be left out entirely, but in our climate it is necessary to provide one or both of these spaces with some protecting fixtures for use in inclement weather. In order to allow the proper place of the unit in a coördinate whole it will usually be necessary to provide a "back-wall" (against the most exposed side); but in this a window or door leading into a corridor will have to be placed, providing the unit, when open, with a continuous current of air. The remaining fourth wall space can then be protected, when necessary, by an awning, or often

the overhanging roof affords all the protection required. The importance of free cross-ventilation cannot be sufficiently insisted on; often

FIG. 157.—OPEN-AIR GALLERY JOINING TWO BUILDINGS.
Gaylord Farm Sanatorium, Wallingford, Conn.

in cubicles, with one wall left out, the air is found stagnant except when it happens that the wind blows into it. Not too much reliance, therefore, must be placed on ventilation by diffusion only; even when the

FIG. 158.—DR. KING'S ORIGINAL "LEAN-TO" FOR EIGHT PATIENTS AT LOOMIS SANATORIUM, LIBERTY, SULLIVAN COUNTY, N. Y.

opening to the outer air is quite large, it must be supplemented by cross-current ventilation.

Fig. 159.—Two "Lean-tos" of the Loomis Sanatorium, Liberty, Sullivan County, N. Y.

Fig. 160.—Dr. King's Modified and Enlarged "Lean-to" (Anne M. Loomis Memorial) for Sixteen Patients. Loomis Sanatorium, Liberty, Sullivan County, N. Y.

The development of the constructive evolution of the patients' quarters in America contains so many suggestive data that it may be well to discuss it here by means of suitable pictures.

It can be safely stated that the type evolved in this country will be adopted more and more, and everywhere, with modifications demanded by local conditions. Figure 156 shows Dr. Millet's latest modification of his shack for one patient. Here we see all the basic principles which have guided the construction of sleeping pavilions: an open part, intended for the patient's accommodation at night, and one inclosed part for his toilet. This general scheme is applied for use by more than one patient in several sanatoria by a utilization of porches and balconies for the housing of patients. This may serve its purpose in many cases,

FIG. 161.—INTERIOR OF SITTING-ROOM, SHOWING LOCKER, TOILET, AND BATH-ROOMS IN THE REAR OF A SIXTEEN-BED "LEAN-TO." Loomis Sanatorium, Liberty, Sullivan County, N. Y.

but in general is not to be recommended because of its obstruction of air and light for the adjoining rooms in the main building.

Sometimes two buildings are joined by a gallery open to the weather on one side, which gives a very well protected and perfectly sufficient accommodation for patients, who for their toilet can retire into one of

the houses. Such an arrangement has been proposed in the constructive planning of some sanatoria, but more often has it been used where old buildings have been utilized for the accommodation of patients, as, for instance, at the Gaylord Farm Sanatorium, in Wallingford, Conn. (Fig. 157).

The first purposeful application of this principle, however, we see carried out, as has already been mentioned, in Dr. King's "lean-to,"

Fig. 162.—One of Two Sleeping Galleries of Dr. King's Sixteen-Bed "Lean-to."

of which several photographs are here given. Figure 158 shows the elevation of King's original "lean-to." It is a very primitive structure, but has served its purpose exceedingly well throughout the year—summer and winter—without discomfort to the patients..

It may be said here that, as a general rule, patients very readily become accustomed to sleeping in these structures, and that it often becomes difficult to induce them to return to other more solidly built apartments.

Dr. King and others have elaborated considerably this original "lean-to," so that greater comfort has been insured at no considerable increase in expenditure.

Figures 159 and 160 show such modifications as are at present in use at the Loomis Sanatorium. They only differ from the original "lean-to" in giving more space throughout, in the sleeping gallery as

FIG. 163.—OPEN-AIR PAVILION CONNECTED WITH MAIN BUILDING. Infirmary rooms upstairs. Maine State Sanatorium. Designed by Dr. Estes Nichols, Hebron, Me.

well as in the locker and toilet rooms. The photographs give a better description of these constructive details than can be done in words. A sitting room is provided in these more recent modifications, occupying the central part of the structure (Fig. 161), and from which immediate

FIG. 164.—DR. HOLDEN'S OPEN-AIR PAVILION, AGNES MEMORIAL SANATORIUM, DENVER, COLO.

access can be had to the locker and toilet rooms. On the sleeping gallery (Fig. 162) sufficient space is to be found in front of the beds for the patients to circulate and to rest on their steamer chairs. It will

be noted that in these structures the protection from the weather is obtained only by an overhanging roof and by an awning.

Other modifications of this "lean-to" scheme show attempts at a more solid protection against the weather. This we see particularly in

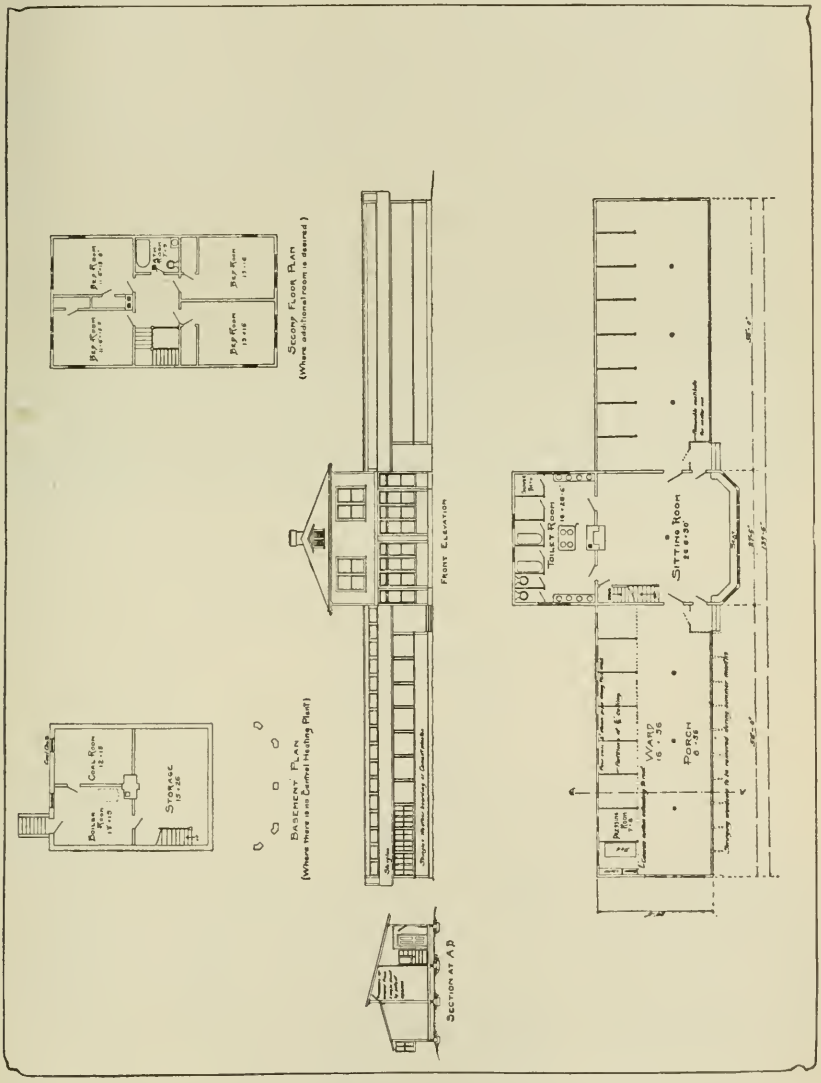

Fig. 165.—Floor Plans of Dr. Holden's Open-air Pavilion at Agnes Memorial Sanatorium, Denver, Colo.

the open-air pavilions at the Maine State Sanatorium, at Hebron, Me. (Fig. 163), and at the Agnes Memorial Sanatorium, in Denver (Figs. 164 and 165). In the latter the protection is obtained by large French windows, which are open to the outside, obstructing in no way the

passage of air. In the former large doors are provided, an arrangement similar to that at the Frimley Sanatoria.

Figure 163 shows, also, how the open-air pavilion can be connected directly with the main building. The pavilion contains no corridor, and access to the main building is to be had directly through one door, the pavilion not being divided up.

At the Agnes Memorial Sanatorium partitions are used to separate the patients, an arrangement which may offer considerable advantage in some institutions where more advanced cases have to be admitted. In

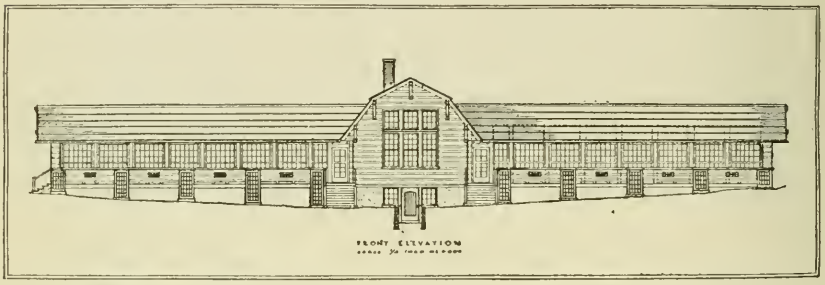

FIG. 166.—BOSTON CONSUMPTIVES' HOSPITAL AT MATTAPAN.
Front elevation of Cottage Ward.

general, it does not seem to be an advisable practice, at least not for patients in the earlier stages, who ought to constitute the major portion of the inmates of the sanatorium.

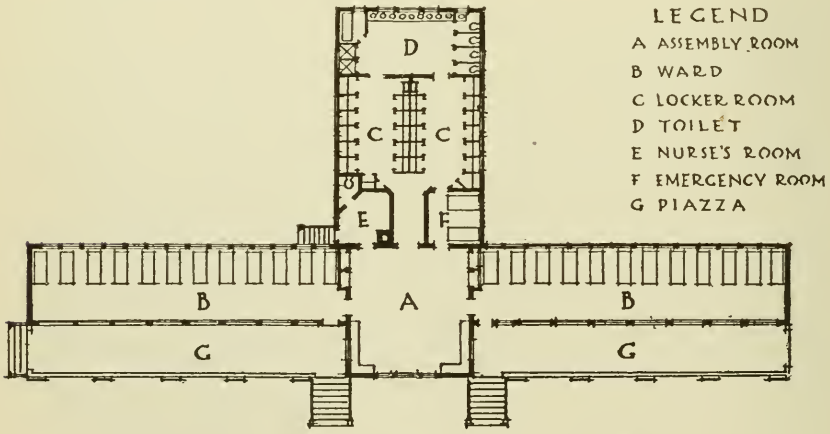

FIG. 167.—BOSTON CONSUMPTIVES' HOSPITAL AT MATTAPAN.
Floor plan of Cottage Ward.

It is of interest to note that the "lean-to" scheme has of late been adopted also for hospitals admitting advanced cases. Figures 166 and

167 show the elevation and the floor plan of a cottage ward at the Boston Consumptives' Hospital at Mattapan. In this admirable plan an emergency room and a nurses' room have been added very appropriately, but

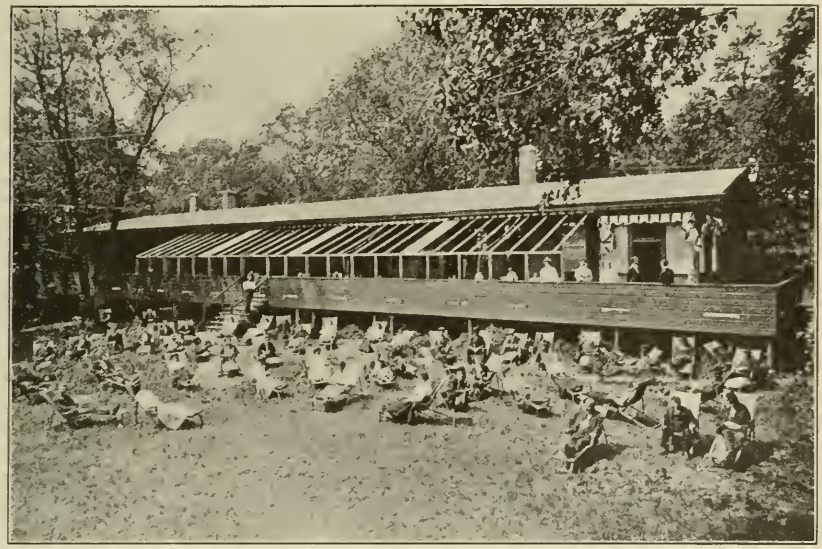

FIG. 168.—BOSTON CONSUMPTIVES' HOSPITAL AT MATTAPAN. Day camp.

on the whole the deviation from the plan of the original "lean-to" of King is but very slight. We also find a similar principle carried out

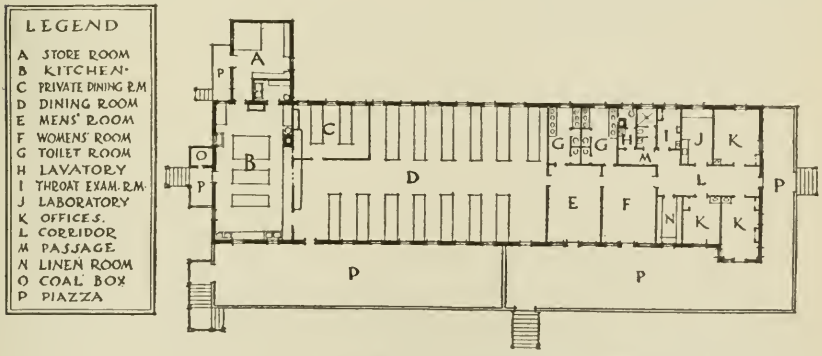

FIG. 169.—BOSTON CONSUMPTIVES' HOSPITAL AT MATTAPAN.
Floor plan of day camp.

in the day-camp building of the same hospital (Figs. 168 and 169), although the inclosed spaces here are used for different purposes than in the other arrangement, a large dining room occupying the greatest space.

Mr. Edwin T. Hall, the successful architect of the Frimley Sanatorium, considers the "two essential details in the design of a sanatorium: First, that all windows or other openings shall be carried up to the ceilings, so that all parts of the rooms and corridors may be scoured with fresh air; second, the sanitary apparatus should be external to the building."

It is seen from the above descriptions that the "lean-to" scheme amply fulfills these two requirements. In his plans, Hall favors single-bed wards, but considers two- and three-bed wards as useful, deviating thereby from the American practice, where as many as sixteen and more are comfortably accommodated in one open-air pavilion. The question as to whether single or multiple wards shall be constructed depends wholly on the class of patients to be accommodated in the sanatorium; but, on the whole, it has been found that the larger ward offers in itself features conducive to better discipline and a better comradeship among the patients, very helpful in a *régime* which, of necessity, requires a long period. The "lean-to" scheme also does away entirely with porches adjoining other buildings, or the *Liegehalle* which forms the characteristic feature of the Continental European sanatorium.

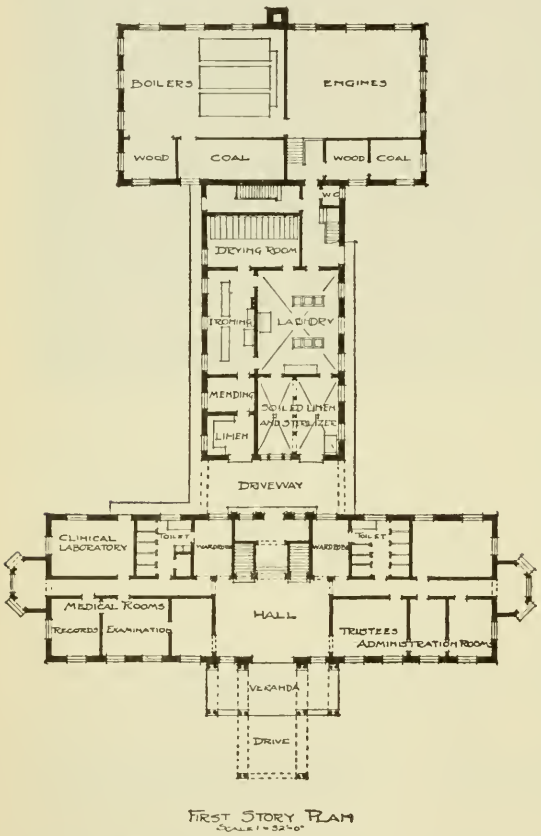

FIG. 170.—MAIN BUILDING (FLOOR PLAN OF FIRST STORY) FOR SANATORIUM FOR 100 PATIENTS. To show distribution of administrative offices, laundry, etc. (J. Gamble Rogers, Architect, N. Y., from suggestions of Dr. A. C. Klebs.)

The disappearance of the *Liegehalle* can only be welcomed, since it has been more and more realized that the treatment by absolute rest during the day, for many hours at a time, is not favorable for permanent recov-

ery, and frequently creates dissatisfaction, unhappiness, and idle habits among the patients. The graduated exercises and labor so successfully carried out by Paterson at Frimley, which have been described in the foregoing chapter, invite a more general adoption in sanatorium practice, and will further and further remove the necessity of special structures for the open-air rest cure.

The material to be used for the building of the patients' quarters will be discussed later, together with the cost of sanatoria in general.

The Administration Building.—Provision for the administrative offices, for the dining room, kitchen, and laundry, and for laboratories, can be made in one central building for institutions of considerable size. It will sometimes be desirable to have separate small houses for physicians' quarters, for the power plant, and for the farm, but that will depend entirely on the amount of money at disposal, and on the purposes of the sanatorium. It may be said, in general, that an elaborateness of planning is undesirable in the majority of institutions. There will have to be institutions where special research is carried on and everything done on a larger scale—as, for instance, in the superb King's Sanatorium at Midhurst, England. The writer has proposed, several years ago, a sanatorium consisting of an administration building, together with accommodations for the patients in "lean-tos." The adjoining plans (Figs. 170 to 172) may prove suggestive to anyone contemplating the erection of a

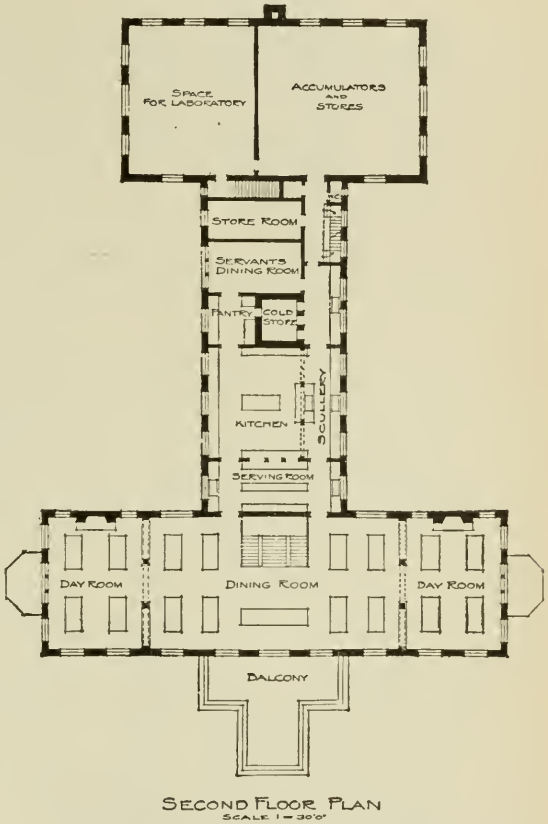

FIG. 171.—MAIN BUILDING (FLOOR PLAN OF SECOND STORY) FOR SANATORIUM FOR 100 PATIENTS. To show distribution of dining room, pantry, kitchen, etc. Above are rooms for physicians, nurses, and help. (J. Gamble Rogers, Architect, from suggestions of Dr. A. C. Klebs.)

larger sanatorium. It is not necessary to describe in detail these plans; they are self-explanatory. It may, however, be well to state that the space in the second floor assigned to the dining room in the front part of the structure seemed to be more desirable than any other, because of its exposure to both light and air from all sides. Accommodations for help are to be found in the third story above the kitchen.

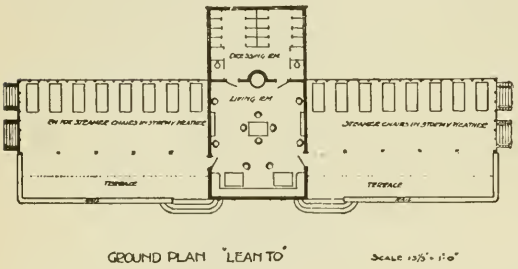

Fig. 172.—H. M. King's Type of 16-Bed "Lean-to" in Connection with Main Building.

A very similar scheme has been adopted most recently in the planning of the Maryland Tuberculosis Sanatorium, at Sabillasville, Md. (Fig. 173), an institution intended for one hundred patients. It will be advisable in the planning of an administration building to have it so arranged that it can be easily added to, especially in the spaces assigned to the dining room and the kitchen departments. When the patients are accommodated at night in "lean-tos," these can be added to more or less indefinitely, while the administration building, if not planned with a view to a possible growth of the institution, is more or less an unchangeable feature of the sanatorium.

General Planning of the Sanatorium Building.—If the patients are accommodated in shacks or "lean-tos," these latter are to be placed as near as possible to the administration building without suffering thereby from too great an obstruction of light and air. In some of the existing sanatoria, some of the shacks or "lean-tos" are entirely too far removed from the central building, necessitating considerable walking for the patients to reach the dining room at meal times. It seems to the writer that the arrangement as provided at the Maryland sanatorium is one of the best. Figure 174 shows this clearly.

Building Material and Cost.—On the selection of the building material, the cost of the sanatorium will very largely depend. This subject has been discussed very extensively at the various national and international tuberculosis meetings without ever having brought forth a practical solution of the question. The difficulty of fixing an average cost per bed for a sanatorium meets with considerable difficulty, because the material for building, the land, and labor will vary in different districts. One thing, however, can be said with certainty: that the estimates of cost for popular sanatoria which have been given by some

authors are entirely too high. The minimum figures exceed, in some cases, $1,000 per bed considerably. At such a rate it would be impossible to multiply sanatoria to a desirable degree. It is very essential

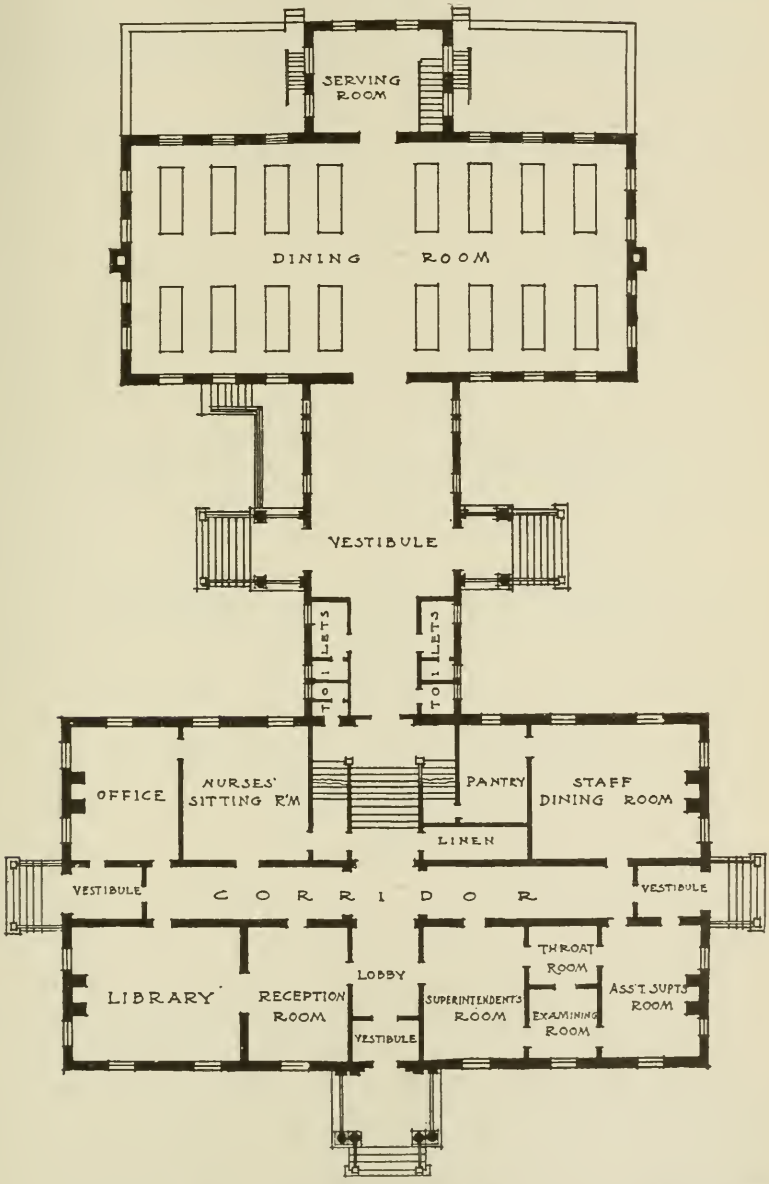

FIG. 173.—FLOOR PLAN OF FIRST FLOOR OF ADMINISTRATION AND INFIRMARY BUILDINGS OF MARYLAND TUBERCULOSIS SANATORIUM AT SABILLASVILLE, MD. (Wyatt & Nölting, Baltimore, architects.)

that it should be understood that at smaller figures perfectly comfortable and efficient buildings can be constructed which will fulfill all the requirements; and it must be said, in addition, that the efficiency of a sanatorium rather decreases in proportion with the increase of comfort and elaborateness, and that therefore any individual or any community contemplating the erection of a sanatorium should not be deterred from

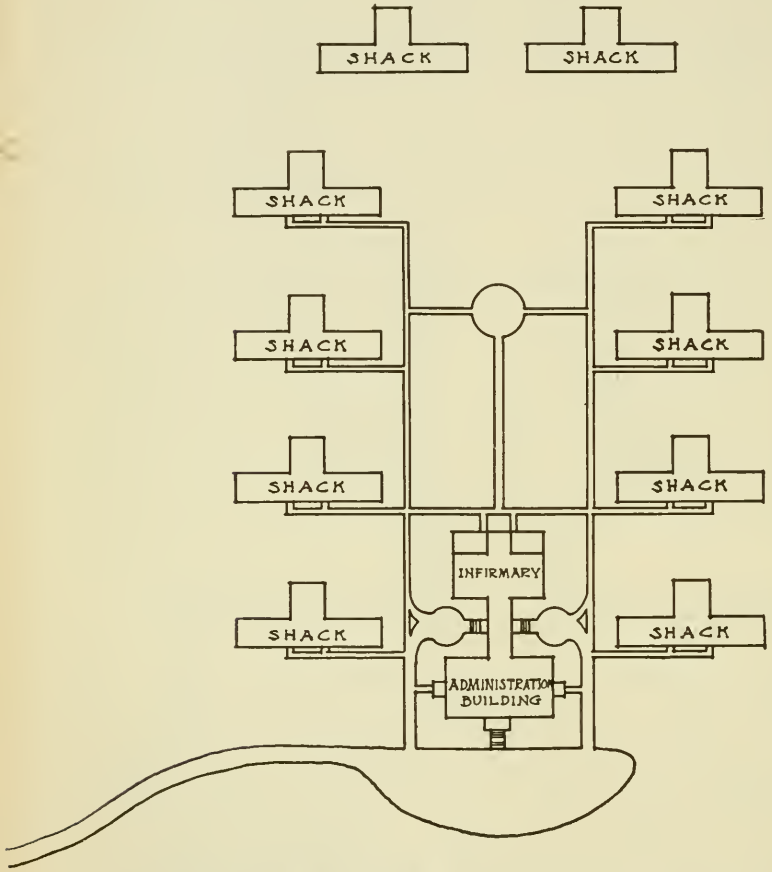

FIG. 174.—BIRD'S-EYE VIEW OF MARYLAND TUBERCULOSIS SANATORIUM, SABILLASVILLE, MD. (Wyatt & Nölting, Baltimore, architects.)

so doing by such estimates based on minimum figures of $1,000 per bed. As said above, the whole question rests to a great extent on the selection of building material, wood being the cheapest and stone the most expensive. In this country, wood has been very largely used. The canvas tent, which is still cheaper, has practically been given up because of its flimsy nature and other disadvantages. When one sees the wooden

châlets in the storm-swept valleys of Switzerland, which have stood the inroads of time and weather for very considerable periods, it does not seem correct to speak of wooden structures as "temporary" buildings. It is of importance to keep this in mind, because the use of wood for sanatorium construction has been very often discouraged, and even ridiculed, because of not offering elements of permanency. Its inflammable nature, of course, is of disadvantage, but very little so for the smaller buildings called for in the "lean-to" type. For a large central administration building, its use may not recommend itself throughout, but it may be stated that there is no objection to its extensive use in the planning of a modern sanatorium. It is possible that cheaper substitutes than wood may soon be found. Some efforts in this direction have been made; for instance, in the *Doecker Barracks*, which are extensively used in Germany in a similar manner as tents are used in this country. Chemically treated cardboard is the chief material used in their construction.

Mr. Edwin T. Hall has of late recommended in his scheme of a standardized expanding sanatorium dry slabs of standard size, which are universal in application for the building unit. It would be interesting and valuable to have further details on this building material. Hall says:

"A sanatorium on these lines, complete, with all essential administrative buildings, to suit any required number of beds, with drains fitted to kitchen and laundry, and water storage, can be erected on a suitable and reasonably accessible site at a cost of about £85 ($425) to £105 ($525) per bed, depending upon its size."

This scheme, it would seem, merits distinct attention as one coming from so experienced an architect as the builder of the Frimley Sanatorium. The estimates for sanatoria in this country, with wood entering primarily into its construction, does not exceed these figures given by Mr. Hall. They would help to fulfill the desiderata recently expressed by Heron: "All poor consumptives should be sent into sanatoria for their own sakes, and for the sake of the health of the community. This could not be done if sanatoria were built costing $1,000 to $4,000 per bed. A sanatorium well equipped for the service of the poor should not cost more than $400 per bed."

Management and Sanatorium Régime.—It is not necessary to enter here in detail into the administrative features of the sanatorium, nor is it necessary to outline the hygienic and dietetic *régime* which is followed in several institutions. The former will have to vary according to circumstances, and the latter is carried out on the principles already discussed in the foregoing chapter. It is desirable, however, to point out again that in the future it will become more and more necessary

to utilize the available working capacity of the patients toward the maintenance of the institution; and it will be of great advantage if it becomes more and more understood that in such a plan not the interests of the institution itself are kept in mind as much as the benefit to the patients themselves. Many of those being in charge of sanatoria have complained about the great difficulty of inducing patients to do anything else during their sojourn in the sanatorium than to take care of themselves; but, on the other hand, we have many reports from sanatoria where a purposeful, energetic scheme of providing useful work for the patients has succeeded. To restore the patient's *embonpoint* and to destroy his working energy and capacity has been for too long the result of a sanatorium *régime*, and it is high time that a greater amount of common sense be applied to these highly important questions. The purpose of the sanatorium *régime* must be to maintain or to improve the patient's working capacity, and that cannot be accomplished by a long-continued idleness. If such idleness is the only means by which a patient can hold in check his symptoms of disease, then the place for such a patient is not in a sanatorium, but in a hospital, from whence, perhaps, at some future time, if his condition continues to improve, he may be returned to the sanatorium. Such considerations will fix more definitely the range of usefulness of the sanatorium, and will, perhaps, enhance the position of the hospital to receive all kinds of patients suffering from tuberculosis, and admitted particularly from the large centers of population. The plans of institutional provision for sufferers from tuberculosis have not yet reached the last stage of evolution; but it is very likely that it will be found in a successful coöperation of a receiving hospital and multiple sanatoria.

CHAPTER IV

CLIMATIC TREATMENT

THE PHYSIOLOGY OF CLIMATE

By HENRY SEWALL

RELATION OF CLIMATE TO PHYSICAL AND PSYCHICAL CONDITION

Medical climatology is based on the theory that the *physiologic* activities of the human mechanism are specifically stimulated or depressed, made easier or more difficult, according to the nature of the climatic environment. It would seem to be self-evident that every vital function must react in a definite way to definite changes in the physical factors of climate.

Unfortunately for the solution of the problem, the scientific observer cannot often test the effect of specific physical conditions or of isolated functions, but must deduce conclusions from the resultants of many interacting variables.

In the living body the coördination of various activities is relegated to a special mechanism—the nervous system—through whose interference the response of any tissue to a stimulus is modified by the associated effects on other tissues. For example, when a living heart, isolated from the body, is perfused with a nutrient solution, its rate of beat will remain unchanged through a wide range of resistance to outflow from it. The heart will simply contract more or less forcibly, according to the work imposed on it. But in the normal body an increase of resistance to outflow from the heart at once excites a regulator apparatus through which not only is its rhythm slowed, but a profound influence is impressed on the vasomotor mechanism, not to speak of more remote effects.

Many similar illustrations might be furnished of the important fact that the intrinsic action of a stimulus on a certain organ is apt to be completely masked by the associated reactions of other mechanisms. Nevertheless, nothing is more certain than that such a hypothetical increase of resistance to outflow from the heart would produce in it a

vital reaction of far-reaching import, the simplest manifestation of which would be found in hypertrophy of the organ.

The illustration will serve its purpose if it makes clear the position that the reaction of the animal organism to a stimulus, of which a climatic change may be regarded as a very complex example, is at least twofold in its nature. First, there is a response through the modification in coördination of the vital activities. This is an attribute of the nervous system, and its effect is immediate. Second, there proceeds a change in every tissue, the nature and extent of which depends on the reaction of that tissue to the variation of physical and chemical forces acting on it. We are here contemplating the physiology of organic nutrition whose elaboration is gradual and its effects remote.

We have thus far considered only the relations of climatic influences to that part of the nervous system which is concerned with the vegetative functions. But, as it is conceded that there is a physiology of climate, still more is it apparent that the effects on the human organism of place and change of place depend primarily on reactions of the *psychical* functions, and that therefore a consideration of psychology is indispensable to any broad conception of medical climatology.

The difference in feeling, ranging from depressing lassitude to exhilarant energy, or from gloom to joy, which may be based on conditions of weather and climate, is familiar to everyone. Not so evident is the reaction of the psychic state on the vegetative processes of metabolism. That such relations exist, though the science which should classify them may have no name, cannot be gainsaid. Brackett, Stone, and Low ('04) give reason for believing that painful mental emotions, such as fright, can produce profound disturbances of metabolism denoted by acetonuria, and marked by vomiting, collapse, or even death. The inevitable influence of the psychic state on physiologic function has become the most prominent doctrine of modern therapeutics, and so demonstrable are the interaction of mind and living matter, that a powerful sect, an unwilling handmaid of science, has been founded on its facts.

In a preceding paragraph there was suggested an antagonism between the vital effects immediately attendant on a change of climate, and those, often totally different in character, which may develop during permanent residence. In short, a change of scene, irrespective of the character of the environment, has often, temporarily, a mysterious influence for good on the living organism. As pointed out above, the first vital reactions to new climatic conditions involve especially the nervous system, the final effects are dependent on the modified metabolism of the individual organs, and this may or may not be conducive to the efficiency of the body as a whole.

The necessity of a *change* in the intensity of physical stimuli to

properly develop physiologic functions seems to be an inherent demand of living matter. Du Bois-Reymond was the first to demonstrate that it is the rate of change in intensity of an artificial stimulus which determines the excitement of nerve tissue. It is an elementary fact of physiology that fatigue progressively blunts the sensory impression aroused by a steady irritation. Erlanger and Hooker ('04) have gone far to show that the variation of arterial blood-pressure incident to the normal cardiac cycle, the pulse-pressure, provides a succession of shocks which is indispensable to the normal activity of the tissues.

Huggard ('06) records as an apparent exception to the laws of medical climatology, that "the newcomer from a temperate climate for a time tolerates the extreme cold of the arctic regions and the extreme heat of the tropics better than do the inhabitants or natives themselves." After a time, however, the immigrant becomes abnormally susceptible to the chill of cold or a victim to the listlessness induced by excessive heat. So far from being an exception, in the light of the foregoing discussion, it seems to the writer that such a result is just what should be expected.

A frequent experience of physicians who deal with cases of pulmonary tuberculosis in health resorts apparently belongs to the same category. An invalid who leaves a favorable environment and returns to former scenes and habits may, for a time, lay on weight and acquire a feeling of well-being which seem to betoken a new lease on life. But too often the forces of disease advance under the mask of improvement, until vital resistance is hopelessly undermined. This may also be a basis, in part, of the popular impression that people may "wear out" a climate, at least in so far as an occasional change of residence is essential to maintain the normal health. Dwellers in stimulating high climates seem especially to feel the necessity for a descent, now and then, to lower levels.

Every change of environment leads to physiologic reactions which manifest themselves primarily as efforts of nervous coördination. The element of time is an important factor in the accomplishment of this vital adjustment. The process of physiologic adaptation to new physical conditions is commonly known as acclimatization. The perfection of acclimatization is measured by the machine efficiency attained by the living body; the resistance to its accomplishment is measured by the climatic physical differences to be overcome and by the individual and racial vitality of the reacting organism. The final outcome, whether the living mechanism increases in power or gradually succumbs to obstacles which it cannot surmount, is a problem of nutrition which involves as variables the vital forces of all living cells.

The clinician who deals with impoverished constitutions has learned that physical and mental rest on the part of his patient is indispensable

in order that the physiologic powers may attain their new coördinations unimpeded. The physiologist has demonstrated that training, or graduated exercise of functions in the direction demanded, is of paramount necessity to machine efficiency under radically changed climatic conditions.

CLASSIFICATION OF CLIMATES

It is impossible to make a classification of climates in which the groups shall be qualitatively sharply distinguished from one another. Many schemes of division have been proposed, according to the point of view of the observer. It is curious to note that the most elaborate systems are but natural extensions of Aristotle's original conception, that the properties of matter are all derived from four elements—earth, air, fire, and water. The principal physical factors that determine climate are temperature, light, humidity, air movement, air density, water, and soil. Actual climates depend on various combinations of these factors.

Medical climatologists have attempted to make their geographical survey along lines determined by the physiologic reactions of the organism. Thus Weber ('04) makes a division into—

I. Sea and Coast Climates.
II. Inland Climates.
    A. Of High Altitudes.
    B. Of Moderate and Low Altitudes.

Another common geographic division is into zones parallel to the equator. Thus: (1) Tropical, (2) subtropical, (3) temperate, (4) cold, (5) arctic. These schemata, when further elaborated, put in apposition geographic and physiologic data in a form very convenient to the medical climatologist.

Huggard ('06) in his important work proposes a purely physiologic basis of classification, and divides climates according to the demands made on the living body for the production of heat. As the rate of heat production is the surest measure of the activity of vital metabolism, the effect on this function is obviously the most important physiologic feature of climatic action, yet Huggard's classification of climates, according to this single principle, although most illuminating, is probably the most complex that has appeared. As a matter of fact, the student of medical climatology must aim to learn not only the definite physiologic reactions to definite meteorologic conditions, but also the empiric biologic results of geographic distribution. In therapeutic practice we estimate the complex of climatic conditions that is best suited to a definite

case, and then select that resort which most nearly fulfills the physical demands, after due consideration of its accessibility, social surroundings, and expensiveness.

Our choice of a climate for an invalid is usually determined by our conception of the total demand for physiologic reaction made by the climate, and of the invalid's capacity to respond thereto. According to this principle, climates may be divided into two general groups, including (1) those which are sedative, or relaxing, or even enervating, (2) those which are stimulating.

The main meteorologic factors in medical climatology are *temperature* and *humidity*. Their relations are determined by distance from the equator, distance from the sea, and elevation above the sea; and, in turn, they determine the weather conditions in any definite locus.

Dry air is nearly diathermanous. The sun's heat would penetrate such an atmosphere unimpeded, and, being absorbed by the soil, would raise its temperature accordingly. In a dry climate a solar thermometer, an instrument with blackened bulb suspended *in vacuo*, may show an extraordinary elevation of temperature when suspended in the sun's rays, but a peculiarly low degree of heat when moved a short distance into the shade. At night time, the earth rapidly returns its absorbed heat by radiation, and the air temperature falls very low. A person exposed to the sun's rays would both absorb and radiate heat rapidly; the sensation experienced might vary from one of comfortable warmth to intolerable heat. In climates where such conditions are approached it is possible, with shade temperature below 0° F., to sit in the sun in perfect comfort and without wraps. To him who sleeps in the open air in summer, the nights are always cool, but within walls which have been baked throughout the glaring day, the radiated heat may be oppressive for many hours.

It is one of the most extraordinary features of dry, as contrasted with moist climates, that the range of *sensible* as compared with *physical* temperatures is much less in the former than in the latter. That is to say, a given air temperature in summer in a dry climate would seem much less oppressive than the same degree of heat registered in a moist atmosphere. Conversely, the intensity and penetration of the winter's cold, as measured by sensation, is definitely increased, at a given temperature, by the amount of moisture in the air.

M. W. Harrington ('93), formerly chief of the United States Weather Bureau, offered an explanation of these facts by likening the human body, in its reaction to temperature, to a wet-bulb thermometer. "The sensible temperatures depend on evaporation, and when evaporation takes place they are invariably lower than the shade temperatures given in meteorological tables. . . . The reduction of temperature

caused by evaporation depends on the rapidity with which evaporation takes place, and this in turn on the amount of moisture already in the air."

Although there is much truth in this aspect of the subject, unfortunately, as pointed out by Phillips ('96), the problem is very much more complex than this conception would indicate, and we must conclude with Phillips "that for the time being we have no index of sensible temperature, and the use of the indications of any one meteorologic instrument for such purpose can only give under the most favorable conditions but a rude approximation to the truth, and too remote to be of much practical service."

In a personal communication to the writer, this author surmises that the nervous irritability of the skin is greatly enhanced by moisture in the air, and *vice versa*. This ingenious idea is capable of explaining largely the want of parallelism between the curves of sensible and physical temperature.

The problem is evidently one of psychology as well as physiology. Various areas of a person's skin may give the same subjective temperature sensation, while, measured by the surface thermometer, they exhibit widely different degrees of warmth. The facts seem to indicate that thermal sensations respond to finer variations of a temperature when the skin is moist than when it is dry, and that the thermometric reading which corresponds at any moment to physiologically indifferent temperature sensation has a variable value, which is largely dependent on the mean of nervous reactions which have preceded the period of comparison.

Huggard ('06) quotes from v. Humboldt practical observations which illustrate this subject: "We had not yet been two months in the hot zone, and already our organs were so sensitive to the slightest change of temperature that, though shivering with cold, we were unable to sleep, and to our astonishment we saw that our thermometer registered 21.8° C. (71.24° F.). In the year 1803, when we were at Guayaquil, the natives of the place complained of cold and wrapped themselves up when the thermometer fell to 23.8° C. (74.84° F.), while at 30.5° C. (86.9° F.) they found the heat oppressive. . . . From all these observations it appears that in low-lying tropical countries, where the temperature by day is almost constantly over 27° C. (80.6° F.), one finds it necessary to cover oneself up at night whenever in this moist air the thermometer falls four or five degrees."

It is usually assumed that temperature sensations, so far as they are modified by moisture in the air, run parallel with the relative humidity. This physical relation no doubt regulates, *cæteris paribus*, the rate of evaporation of moisture from the skin, as from any other surface;

nevertheless, the absolute quantity of watery vapor in the air cannot be indifferent to the skin and thermal sensations. Thus in the arctic regions, while the relative humidity is very high on account of the very low temperature, "the air is almost absolutely dry, and yet no complaints are heard about the dryness of the air and there is no mention of its effects" (Ham, '03).

The living body loses heat chiefly through the skin, according to the activity of the processes of radiation, conduction, evaporation, and convection. The latter factor is of very subsidiary importance in still air, but in moving air the latter two phenomena may be intensified to such a degree that the physiologic relations of a climatic locus may be chiefly determined by the wind. Gentle breezes, with a rate of movement between five and ten miles an hour, probably have great hygienic value, both in purifying the air and in acting as an agreeable physiologic stimulus. But strong winds, particularly when the humidity is high and the temperature low, have an extraordinary power of abstracting heat from the body and producing physiologic chill. A moist surface dries most quickly in a current of hot, dry air; but, as pointed out by Huggard ('06), wind does not greatly increase the heat loss of the body to dry, warm air, but it greatly accelerates the abstraction of heat by cold air, especially when moist. "Clothing gives sufficient protection against dry, but not against moist, cold air."

From the viewpoint of medical climatology, it would seem that the environment capable of producing the highest machine efficiency in any definite individual would be one in which the physical conditions excite a maximal mean metabolism in all the living tissues, in which every physiologic function of the body is stimulated to its full capacity of reaction. The range of physiologic reaction may be greatly narrowed by disease, now in one tissue, now in another. In health the range of vital elasticity, so to speak, tends to continually contract with disuse of the respective function.

In the hot, moist air of the low-lying tropics the mechanisms of heat elimination are exercised to the maximum, while the centers of heat production receive but a minimum of their normal stimulation; therefore, as cited by v. Humboldt, a very slight fall of external temperature surpasses the bounds of physiologic accommodation as measured by sensation. On the contrary, in the arctic regions, the heat-producing apparatus is whipped into excessive activity, while the machinery of heat dissipation is in very languid motion. On some intermediate isothermal lines we may expect to find a set of physical conditions which, for every given organism, will call out the largest reaction, and produce the greatest physiologic efficiency from every tissue element consonant with the full coördination of that element with its neighbors.

It has been pointed out that isothermal lines constructed from the readings of the dry- and wet-bulb thermometers depart widely from parallelism. Whatever may be its explanation, there is no doubt that what may be called the iso-æsthesodic lines, or curves of sensation, as concerned with temperature, depend more especially on conditions which determine the stand of the wet-bulb than of the dry-bulb instrument. If this be true, the estimate of the physiologic reactions induced by a given climate could be better made from a meteorologic record of humidities than of temperatures alone; and, manifestly, supposing a physical-physiologic equation to have been constructed from these data, the element of wind might enter and at once destroy the balance of the terms.

It is an ideal of medical climatology, as the writer conceives it, to trace on the map of the world æsthesodic and kinesodic curves, the course of which would be determined by the integrated reactions of the sensory and motor functions, respectively, of the living organism to local climatic conditions. Such reactions would represent the physiologic mean of responses from all the individual mechanisms of the body.

The aims of climatology, stated thus abstractly, are actually sought in climatologic practice. For example, in locating a patient suffering from a lesion of the heart or kidney, the medical adviser seeks out that environment in which he conceives the physical conditions will throw the least possible strain on the affected organ. And in dealing with infections, such as tuberculosis, in which the welfare of the patient depends on the sum of his powers of "vital resistance," it is endeavored to select a climate which shall stimulate to the utmost the forces of physiologic reaction, considered as a whole.

So complex is the living organism, that its reactions to the permutations of the meteorologic elements of climate cannot possibly be deduced from known principles. Applied medical climatology must be built on a broad foundation of physiologic experimentation, harmonized with carefully sifted empiric observation.

EFFECT OF EXCESSIVE ILLUMINATION

From the beginning of the human race, light has been a symbol of material and spiritual good. Universal experience confirms the results of physiologic and bacteriologic experiment, which prove that light is indispensable to the welfare of sentient organisms, and unequaled in destructive effects on microbic enemies of the higher beings. Health resorts generally are, to a large extent, valued in proportion to the number of hours of actual sunshine recorded in them. Nevertheless, there is

fair presumption that the intensity of illumination may easily surpass a degree up to which it becomes beneficial.

Woodruff ('05) has brought together a considerable array of facts to support the hypothesis that members of northern races, especially individuals having blond complexions, suffer materially when living in the tropics from intense solar illumination. His reasoning is based on assumed absorption of the sun's rays by the blond skin and excessive catabolism induced thereby. The pigment in the skin of brunettes and the darker races more or less effectually screens the living tissues from the deleterious radiations.

Huggard ('06) dwells on the element of temperature as determining the ability of races to bear transplantation to foreign lands. "As a matter of fact," he says, "a man becomes acclimatized readily only in countries having very nearly the same mean temperature as the country to which his race belongs. Individuals may live in seeming health in climates much hotter or colder than their own. But their posterity does not fare equally well; their descendants melt away, and hardly a survivor remains to the third or fourth generation. The attempt to colonize directly a land having a mean temperature widely different from that of the native land of the colonists has always ended in failure." It is very probable that the factor of illumination-intensity plays an important part in the ruling influence of insolation, as described by Huggard.

According to Woodruff ('05), the deleterious influence of strong sunlight in the tropics is manifested especially on the nervous system, and leads to neurasthenia and associated disorders. This author's ideas, if true, should be of great value to the medical climatologist as a guide to a therapeutic selection of climates, not only according to the complexion but the temperament of his patients. But the problem is evidently much more complex than the presentation of Woodruff would indicate.

HIGH ALTITUDES

The factors of temperature and humidity probably have much to do with increasing the sensitiveness of the skin to the luminous rays, and, above all, the equability of temperature and moisture, when their degree is high, must be potent as a cause of vital debility. Residence at high altitudes should, according to the assumption of Woodruff, furnish the prime conditions for the development of the neurasthenic state. For in such resorts the sunlight is unrivaled in strength and duration, and especially rich in the very refrangible rays which are known to chiefly affect metabolism in the skin, while at the same time the air is dry and cool.

While it is generally admitted that invalids of nervous temperament are apt to do badly at even moderately high altitudes, and that most persons, especially females, feel a need of change after prolonged residence under such conditions, it is improbable that any one factor is of predominant importance in producing this effect. An experience of over seventeen years in Denver, near the fortieth parallel of latitude and at one mile above sea level, where the sunshine in winter is sixty-two per cent of a possible monthly mean of one hundred and eighty-eight hours, convinces the writer that the brightness of a winter's day induces an exhilaration which rather increases than decreases as the years go by. Neither can he recall, among the considerable number of pulmonary invalids that have come under his observation, any special relation of complexion to susceptibility to light, nor manifest bearing of this constitutional trait on the course of disease under conditions of high illumination.

The physiologic effects of the various elements of climate have been determined chiefly by a study of extreme conditions. It is as if the therapeutic action of a series of drugs were required to be deduced from their toxic powers. The beneficial results of the open-air treatment in tuberculosis have especially impressed on medical climatology the truth that the physiologic response of the organism to change in environment is determined by very delicate reactions. Of two similar invalids in this class, the one housed in an ordinary bedroom, well warmed and windows closed, and the other resting under like conditions, but just outside the wall of the house, protected only from high winds, rain, and extremes of temperature, the probabilities would greatly favor the recovery of the latter as compared with the former patient. Climatic therapy is founded on observations of this nature.

Of late years the advance of medical climatology has received its chief stimulus through a study of the physiologic reactions incident to life in high altitudes. Systematic observations and experiments by trained physiologists, beginning in the laboratory of Paul Bert ('78) and leading up to the recent researches on Monte Rosa, conducted by the party headed by Zuntz and Loewy ('06), go far toward giving medical climatology a foundation in exact knowledge.

High climates in temperate latitudes embrace the special characters of widely different regions, with added qualities peculiar to themselves. There are found the intense illumination of the tropics, but the low humidity and variable temperature of inland deserts. Though the heat of the air, as measured by the thermometer, rapidly passes through wide variations, the sensible temperature may apparently oscillate less largely than under the equable conditions of a sea coast. In addition, the rarefaction of the atmosphere induces a special chain of physiologic reac-

tions unparalleled by any other climatic environment. The monograph of Zuntz and his collaborators, which has already been reviewed by the writer (Sewall, '04), forms an admirable basis for the discussion of the vital effects of lowered barometric pressure.

The futility of attempting to deduce the nature of physiologic reactions from a knowledge of the mechanical conditions involved is well illustrated in this field of study.

Nearly a century and a quarter ago the great physiologist, Albrecht v. Haller, originated the "cupping-glass" theory of the effects produced on the circulation in the living through diminution of atmospheric pressure. That idea has continued to cling to the mind of student and layman alike. The facts of "caisson disease," a disorder produced by too sudden decompression after a sojourn in highly condensed air, are proof positive that gases dissolved in the body fluids may be liberated with destructive effects when the air tension on the surface of the body is suddenly diminished to a sufficient degree, very much as a bottle of aërated water froths when the cork is withdrawn. Most competent observers (Hill, '07) appear to agree, however, that, under ordinary conditions of changing atmospheric pressure, the variations are so gradual that that equilibrium between internal and external air tensions is practically continuous. Nevertheless, the clinical observer at high altitudes is frequently impressed with facts which seem to confirm the conclusions of H. Kronecker ('03).

According to this author, the lowering of atmospheric pressure exercises an effect on the distribution of blood in the body in such a manner as to cause a relative accumulation in those superficial vessels which have the least mechanical support; such are evidently the blood-vessels of the lungs. Therefore diminution of atmospheric pressure would lead to pulmonary congestion and a tendency to stagnation of blood in the lungs.

There is, unfortunately, still wanting crucial demonstration of the facts pertaining to the distribution, rate of movement, and pressure values of the blood as influenced by air density. When the lungs are at rest and the glottis is open, the air-pressure within the pulmonary alveoli is probably practically identical with that on the surface of the body, and the tension of the blood gases very rapidly reaches the same value. This mechanical equilibrium would exist, under the same conditions, at all altitudes tolerable to life. At the onset of an inspiratory movement, however, there is at once a fall in the tension of the alveolar air, and the pressure on and within the body at large remaining the same, the expanding walls of the thorax act like a veritable cupping glass, drawing blood into the right heart and lungs. The lack of tissue support about the pulmonary capillaries, their remarkable distensibility

and possible freedom from vasomotor control, puts these vessels peculiarly at the mercy of mere mechanical disturbances.

No diminution of atmospheric pressure affecting simultaneously the skin and pulmonary alveoli should be expected to cause a translation of the incompressible body fluids, simply because the pressure is uniformly distributed. Pent-up gases, as found in the abdominal viscera, expand under such conditions according to known physical laws, and by upward distention of the diaphragm may cause symptoms. Again, if the fall of external air-pressure were extensive and rapid enough, blood gases would be thrown out of solution and, in the following lines of least resistance, might produce movements in the blood mass.

There is, however, an easy physiologic explanation of the physical disturbances in the pulmonary circulation encountered under conditions of lowered barometric pressure. Such a change causes an increase in the depth, and usually in the rate of breathing. Therefore the mechanical force which drives blood to the lungs is proportionately increased. But at the same time it is extremely probable that, under usual conditions, the coördination of the complex mechanisms of circulation and respiration is impaired so that the heart is unable to empty itself efficiently.

The evidence that heart strain may easily be induced in high altitudes, particularly under conditions of muscular exertion, is founded both on common experience and scientific observation. Professor Zuntz and his colleagues especially call attention to the insidious onset and progress of cardiac dilatation under such conditions.

This incapacity is manifested in persons who are unaccustomed to conditions of lowered barometric pressure. As a result of training and during the process of acclimatization, physiologic coördination is reëstablished. Thereafter relative pulmonary congestion is only to be expected especially at high altitudes, because, as will be pointed out later, under such conditions relatively slight exertions are apt to load the lungs with blood faster than the heart can discharge it. It is clear that, though the left ventricle may considerably increase its output, the excessive ratio of inflow to the right heart would soon lead to distention of this viscus and to the distress of cardiac dyspnea.

Paul Bert ('78), in his encyclopedic work on the physiologic influence of barometric pressure, furnished the first evidence that life in high climates modifies the oxygen-carrying function of the blood when he showed that the blood of animals habituated to very high altitudes contained, per volume, considerably more oxygen than that of creatures living in the lowlands. For a decade the importance of Bert's researches was insufficiently recognized, but Viault ('90; '91; '91A; '92), during observations made in the Cordilleras at an altitude of about 14,000 feet,

found that at this elevation his red blood cells numbered about 8,000,000 per cubic millimeter, whereas three weeks before, at sea level, the count was but 5,000,000. A similar polycythemia marked the blood of people who had lived at the high level since birth.

Herein was furnished the first positive evidence that residence in high climates produced a definite, tangible change in the living organism. A considerable literature has since been built on this thesis, of which admirable and critical summaries may be found in the works of Zuntz ('06) and of Tissier ('06).

Of the increase in the red blood count as a result of ascent above sea level there can be no doubt. The only question at issue concerns the meaning of the polycythemia, whether it is due to a real increase in the number of blood corpuscles throughout the body or simply to a redistribution, which leads to turgescence of the superficial vessels from which the enumeration is usually made. In favor of the latter explanation are evidences that the conditions in high climates induce, at least in unacclimated persons, the accumulation of blood corpuscles in the vessels of the skin. Moreover, the increase of blood count with ascent, and its decrease with descent, follow almost immediately the changes in elevation. It is hardly conceivable that the processes of blood formation and destruction could be stimulated to such a rate. Again, Ambard (Tissier, '06), experimenting with dogs confined in pneumatic boxes, showed that even when the barometric pressure was reduced to 450 mm. Hg., the blood in the femoral artery contained per volume rather fewer blood cells than at normal air-pressure.

Investigations by Campbell and Hoagland ('01) on Pike's Peak, in Colorado, and similar researches in the high Alps (Zuntz, *et al.*, '06), have shown that in the rabbit, blood from the ear vessels contains a considerably larger proportion of corpuscles than that taken from the internal organs. In the lowlands no such difference is manifest. Nevertheless, trustworthy observations support the conclusion that rarefaction of the air does, in fact, act as a specific stimulus to the cytogenic function of the bone marrow, leading both to increase in the number of erythrocytes and in the amount of hemoglobin in the body.

The biologic reaction leading to this result develops gradually, and probably reaches its maximum after a variable interval, it may be of several weeks. Individuals differ greatly in the susceptibility of their hemapoietic tissues to the stimulus of rarefied air; young animals constantly show a greater relative polycythemia.[1]

[1] Of interest in this direction are the recent findings of Webb and Williams ('09) of an increase in the number of lymphocytes in high altitude. If confirmed this may explain, at least partly, the beneficial effect of high altitude in tuberculosis. —Editor.

Most suggestive from a theoretic, and valuable from a clinical, standpoint, are the observations conducted by Professor Zuntz and his party on what may be termed the physiology of acclimatization.

The sharply marked vital reactions which occur as result of removal to sufficiently high elevations, and which may be made to vary quantitatively according to the altitude, give to the study of high climates a peculiar biologic interest. It has been shown that in an ascent from the level of the sea the activity of the blood-forming organs is increased. According to the curve constructed by de Bouaille, the red blood corpuscles increase rapidly in number up to the altitude of about 6,500 feet, then more slowly to 13,000 feet, and afterwards very slowly indeed.

When we inquire as to the nature of the stimulus which excites this modification in metabolism, attention is necessarily directed to the lowered oxygen tension of rarefied air. The most trustworthy observations and experiments seem to lead to the conclusion that relative oxygen deficiency in the air is the cause of the major physiologic reactions to lowered barometric pressure. Laboratory experiments show that when shed blood is placed under the receiver of an air pump, oxygen does not begin to break loose from its combination with hemoglobin until the air-pressure has been reduced to 300 mm. Hg., which corresponds to the barometric pressure at an elevation of 17,000 feet above sea level (Foster, '89).

Many of the physiologic disturbances under discussion become well marked at less than half this altitude, where the partial pressure of oxygen in the air is amply sufficient to saturate the blood, provided the physiologic mechanisms are able to appropriate and distribute it to the vital tissues. For the present we must be content to explain the facts by analogy. Facility in any feat of skill requires the development by practice of new coördinations of the nerve-muscle functions. The very processes of secretion and digestion are specifically related to the nature of the aliment, and can be prostrated completely by a sudden radical change in the character of the food.

The absorption of oxygen by the lungs, and its distribution to and appropriation by the tissues, is a chain of vital events not to be explained by the laws of physics alone. Therefore, although the oxygen in the air at an altitude, say, of 10,000 feet, is amply sufficient to supply the necessities of the body, it is not strange that the living protoplasm should show some disturbance in adjusting itself to the reduction in the physical aid to absorption to which it had been habituated. It is self-evident that a physiologic adjustment which compensates a lowered oxygen pressure while the body is at rest may at once be thrown out of balance through the demands of muscular exertion. Thus it is

found to be a constant fact that exercise in high climates produces a greater relative rapidity of heart action, respiration, and general metabolism than is involved in the same expenditure of physical energy in the lowlands.

The physiologic waste of energy is inversely proportional to the grade of acclimatization of the individual. It cannot be too strongly emphasized that removal from a lower to a higher climate demands from the vital powers an extension of their coördinations. So imperative is this demand that the very structure of the body is altered in response to it. The increased hematopoiesis at high altitudes has already been discussed. The work of Zuntz ('06) and his collaborators demonstrates, in addition, the extraordinary fact that in moderately high altitudes metabolism is so modified that there is a laying on of proteid material, even in persons of adult age—a fact without parallel in medical climatology. This modification of nutrition may still further progress after the person under observation has returned to a lower level. This fact furnishes an interesting physical basis for the long persisting benefit from a temporary sojourn in the mountains.

Healthy people may passively ascend to considerable elevations without sensible disturbance of function; but even slight exertion, such as walking a few steps, is apt at once to excite disturbance of circulation and respiration, or, in extreme cases, precipitate the remarkable chain of events involved in "mountain sickness." When invalids seek the higher climates, the deleterious effects of overstrain of the vital powers are apt to outlast the act, and later cause disaster. A heart which is intrinsically weak is liable to dilate so gradually under the overloading induced by exertion that a fatal strain is experienced without the victim realizing its onset. Herein, probably, is the explanation of the not infrequent fatalities occurring among patients with pulmonary tuberculosis, who think they may venture on their customary exercise directly on coming to a higher altitude. Such persons sometimes unnecessarily go to pieces with symptoms of acute pulmonary edema, precipitated, it may be, by very slight exertions. The bright sunshine and the crisp, dry air at high elevations are stimuli which primarily excite the nervous system, and indulgence in a motor response which is proportionate to the sensory stimulation is prone to overtax the vital powers. The physiologic response to the physical conditions encountered in high climates throws special strain on the sensory and coördinating tissue—the nervous system.

We find in experience, what might have been expected from theory, that persons of unstable nervous temperaments are apt to have their morbid symptoms exaggerated at high altitudes. Clinical experience shows, however, that with freedom from excitement and exercise and

proper manipulation of the factors of irritation, there is often, in such cases, to be achieved the good without the ill effects of life at high levels.

It has been abundantly demonstrated that the physiologic effects of high altitudes are such as indicate stimulation of all vital functions with an intensity whose maximum is very high and whose range may be wide. Acclimatization consists in the development of physiologic coördinations within wider limits than usual, as well as in anatomic growth of the tissues which must chiefly bear the burden of excessive function. Careful, gradual preparation of the powers preliminary to ordinary exertions at high altitudes is as important an aid to acclimatization as is the course of training found necessary by an athlete before entering on a physical contest. .

Practical medical climatology seeks to define the climatic conditions which will favor the development of maximum machine efficiency from the physiologic functions of the body, taken as a whole, in men of every variety of constitution. It is important to bear in mind that, as in human society, so in the community of cells forming an organism, the optimum activity of each individual element which contributes to the best interests of the body as a whole is that through which it gives the utmost help to the purposes of its associated neighbors; or, in the language of field sports, it is only through "team work" that an aggregation becomes a successful unit. Therefore, in making a climatic prescription for a definite individual, the medical adviser considers the interests of the weakest function to be paramount. A debilitated heart or kidney may need as thorough relief as possible from the exigencies of its functions; accordingly, in such a case it is usually sought to fix on a climate characterized by a moderate and equable temperature, a fair amount of humidity, and an environment offering stimuli, of whatever sort, varying in frequency and intensity only sufficiently to keep the mind pleasantly interested. These are the physical conditions constituting what is termed a sedative climate.

According to the nature and range of intensity of physical stimuli involved in the environment, the physiologic effect may vary from tonic and bracing to one promoting lassitude. On the other hand, in chronic systemic infections, such as tuberculosis, whose cure is founded, apparently, on the products of vital reactions of living tissues to stimulation, experience confirms the theory that, *mutatis mutandis*, the most favorable environment, such as an outdoor life, is one in which the physiologic response of the vital tissues is pushed toward an extreme. Such conditions determine the stimulating climates, especially as manifested in resorts at high altitudes.

In the infinite variety of more or less morbid conditions which depend on general vital depression from too continuous effort, or when there is debility of one or another of the vital functions without distinct disease, the safest climatic therapeutic advice is founded on the known psychic effects of geographic change.

THE PRINCIPLES OF PHYSIOLOGIC REST

While nothing is more certain than that the functioning powers of an organism demand for their development exercise in overcoming resistances, nevertheless therapeutic experience has established the truth that in many morbid conditions the only safety for the individual is to be found in a condition approaching absolute rest.

In local septic infections it is easy to see how muscular contraction, with its attendant acceleration of the circulation, can disseminate the *materies morbi* and poison the whole body. Though even in this simplest case the *rationale* of successful treatment is obscure enough, the general principle is clear that the healthy organism, undisturbed by functional demands, has extraordinary power to remedy purely local evils in its various parts. Indeed, the very fact of its existence is crucial evidence that a given organism is endowed with a power of constructive metabolism sufficient to have overcome innumerable assaults of opposing forces.

When we recognize the importance of physical rest as an aid to the "resistance" powers of the body in its struggle with infectious disease, it is not difficult to believe that in those intricate disorders arising from maladministration of its nervous and psychic forces the broader principles of physiologic rest must be invoked to accomplish a cure. Lombard, in measuring a series of knee-jerks, has shown that the height of the contraction is at once increased when a sound, so faint as not to be consciously perceived by the subject, breaks the stillness of the air. This is a concrete example of what is doubtless a general truth that every known physical agent, not to mention unknown forces, inevitably excites the sensorium when of sufficient intensity to cross the threshold of irritability of the peripheral afferent nerves. These stimuli, moreover, invariably overflow from the recipient sensory centers, and radiate in currents of greater or less intensity throughout the motor and centrifugal districts of the nervous system. It is capable of satisfactory demonstration that such conscious and subconscious stimuli may operate as pathologic irritants, for they exert upon the nervous system essentially the same disastrous influence as does physical exercise upon the inflamed or infected tissues at large. While it is relatively easy to secure postural quietude through the so-called "rest treatment," it would seem

impossible to prevent the coruscations of sensory impulses throughout a hyperirritable nervous system.

Nevertheless, the therapeutist finds that Nature has provided for her kinetic energies a balance which we know as Inhibition, through which activity may be restrained, conserved, or annulled. It is evident that this field of his labor has become that of psychology, and the assertion may perhaps be ventured that, through the application of what may crudely be included under the term "suggestion," the forces of inhibition may be aroused to restrain and direct the dispersive energies of the neurons. The marvelous clinical rehabilitations which are daily placed to the credit of "psychic" ministrations represent nothing more than the superiority of the inherent, sustaining, conservative resisting powers of protoplasm when freed from what may be called adventitious vital friction. In short, functional metabolism throughout the body has an unmeasured range of adaptability to its normal tasks when freed from aberrant nervous impulses. Such freedom constitutes rest. On reflection it is clear that rest in the sense here involved is not different in kind from that exercise whose energy is not lost in friction, but is directed to functional uses.

CLIMATIC THERAPEUTICS

By W. JARVIS BARLOW

HISTORICAL ASPECTS

It is interesting to read the translations from the Greek and Latin, and note how much the ancient authorities—Hippocrates, Galen, Celsus, and Paulus Æginetes—studied the conditions and factors of climate, and their effect on epidemic and chronic diseases, their views on the air of various places, the water, dust, soil, and so on. Hippocrates, the father of medicine (470 B.C.), speaking of air, water, and places, says: "Whoever wishes to investigate medicine properly should proceed thus: In the first place, to consider the seasons of the year and what effects each of these produces (for they are not at all alike, but differ each from themselves, in regard to their changes); then the winds, the hot and the cold, especially such as are common to all countries, and then such as are peculiar to each locality. You must also consider the qualities of the waters, for as they differ from one another in taste and weight, so also do they differ much in their qualities." He also lays emphasis on the situation of the town or city in respect to the prevailing winds, the rising sun, and the amount of sunshine. In the matter of

soil, he says that one should understand and be particular whether the place is marshy, well wooded, and has a sufficient water supply, and that by knowing these things one will not be in doubt as to the treatment of disease, or make as many mistakes as if he had not been in possession of this knowledge.

Among the aphorisms of Hippocrates which were discussed by Galen and others there are announcements, true in all ages, that are generally accepted in modern times. Some apply to special climatic therapeutics. "The changes of the season most engender diseases, and in the seasons great changes either of heat or of cold, and the rest agreeably to the same rule." "Of natures (temperaments?), some are well or ill adapted for summer and some for winter." Nothing can be truer than this in our modern teaching. "Of diseases and ages, certain of them are well or ill adapted to different seasons, places, and kinds of diet." "Of the constitutions of the year, the dry, upon the whole, are more healthy than the rainy, and attended with less mortality." "Autumn is a bad season for persons in consumption." "The spring is most healthy and least mortal." Although these aphorisms were written many years before Christ, nothing truer can be said to-day.

A. Cornelius Celsus, born 25 B.C., whose medical writings in Latin are so well known, in speaking of phthisis stated: "But if the distemper is more violent, and there is a true phthisis, it is necessary to oppose its beginnings, for if this distemper continues long, it is not easily overcome. If the patient's condition allow, he must take a long sea voyage, change his climate, taking care to remove to a grosser one than that he leaves, and therefore from Italy to Alexandria is a very agreeable change. . . . If the weakness will not admit of that, it is very proper to sail in a ship, but not too far; but if any circumstances render the sailing unfit, the body must be moved on a litter or some other way. . . ."

Paulus Ægineta, who wrote in the seventh century after Christ, laid special emphasis on pure air and the fact that the different qualities, such as heat, cold, dryness, or humidity, have not the same effect on all; that it is a matter of temperament with regard to the benefit derived.

Thus it is seen that not only a change of surroundings, but a change of climate, was recommended in the earliest records. Often the benefit that such change brought to the patients was attributed to nonatmospheric elements. Springs were frequently sought for their mineral effects, agricultural districts for their dairy products, vicinities of forests for their healing qualities. The scientific application and appreciation of climate as such, and its effects on disease, belong to more modern days and have gone hand in hand with the study of meteorology.

Richard Morton (1637) (Osler, '04), in speaking of the prevention of tuberculosis, advocated "open, fresh, kindly air, and such as is free from the smoke of coals."

Benjamin Rush, in 1793, writing on the palliative treatment, says: "The first remedy under this head is a dry situation. . . . The higher and drier the situation which is chosen for this purpose the better. . . . Much has been said in favor of sea voyages in consumption. In the mild degrees of the disease they certainly have done service; but I suspect the relief given or the cures performed by them should be confined chiefly to seafaring people, who add to the benefits of a constant change of pure air a share of the invigorating exercises of navigating the ship."

GENERAL DEFINITION OF CLIMATOTHERAPY

Climatotherapy is the application of climatic factors in the treatment of disease.

Meteorologically considered, climate may be said to depend on (1) distance from the equator, (2) the elevation above the sea level, and (3) the distribution of the land and water over the surface area. The amount of sunshine, heat, and humidity will be dependent on the above factors.

In all diseases, but especially in tuberculosis, many other factors, independent of atmospheric conditions, must be embraced within the term climatic treatment. The individuality of the patient, his environment, his resources, his intellectuality, his mental attitude, and the stage of the disease must be considered before a change of climate is advised. Then, too, it must be remembered that one place may offer ideal atmospheric conditions for a climatic change, while it gives unfit or no accommodations, with poor food and little comfort. All these factors not dependent on meteorologic conditions are included in the term climatotherapy, and in this sense the subject will here be treated.

IS THERE A SPECIFIC CLIMATE FOR PULMONARY TUBERCULOSIS?

No climate is a specific for this disease. In choosing a climate, individualization must be the keynote of treatment. The old idea of a particular zone or a climate conferring immunity to tuberculosis has been generally given up. There is still reason and good authority to believe that tuberculosis exists less in dry regions, either in dry forest places or in elevated and low-lying desert lands. Such places are rela-

tively free from tuberculosis because the inhabitants live out of doors, in the pure air, in localities not yet contaminated by settled districts. When these places are thickly populated and cities are formed, tuberculosis is no longer rare, even among the natives. In other words, it is the social life and unhygienic conditions which beget the spread of tuberculosis and not the climate that prevents it. This is shown in the American Indian, when taken from his native environment and placed in settled districts or under changed social conditions. The increasing mortality from tuberculosis of the American negro (Brandt, '03) since the war also verifies this point. Before the war he was well housed, cared for, living an agricultural life. Since the war the negroes have drifted into the cities, living under most unhygienic conditions. Havard ('05), Assistant Surgeon General, U. S. A., writing on the mortality in tropical climates, shows that it is more the local social conditions than any factor of climate that is responsible for the great prevalence and mortality of tuberculosis in Manila and Havana.

Treatment of tuberculosis by climate requires more than merely the study and knowledge of the meteorologic conditions, and yet in no other disease does climate play so important a therapeutic rôle. Climatotherapy is the close study of individual tastes for each and every patient, and in fact all conditions that arise in relation to the place selected—atmospheric, topographic, sociologic, psychic, and economic. Too much stress has been laid on temperature, humidity, and altitude to the exclusion of other factors, such as social and hygienic conditions, proper and congenial environment.

More and more are we studying the individual requirements of climates for tuberculosis, and a patient should never be advised to make a change without a knowledge of the conditions to which he will be subjected. It is not so many years ago when it seemed necessary to send the patients to a climate heralded for some specific quality, and a relaxing climate, like Madeira, was the favorite choice. Then came the inland climates, and later the tonic and stimulating effects of the high, dry, cold air of the Alps and Rockies; and more recently, still, has come the realization that tuberculosis can be treated successfully in any locality. Some modern therapists deny the efficacy of any climate, one holding (Flick, '06) "that there is absolutely nothing in climate in tuberculosis." The difficulty lies in the fact that the pendulum swings too far whenever anything new in medicine is exploited, so that when cures are made in the moist climates there are those who seem to lose sight of how much more might be done with the added climatic factors. Fortunately, the pendulum has swung back to a more rational position, so that to-day, with our individualization of treatment, every factor, climatic or nonclimatic, is utilized.

PRINCIPAL TYPES OF CLIMATE

The classification of climates has always been a difficult matter to all climatologists. A method based on geographical position (distance from the sea and distance from the equator) offers less complications than one dependent on physiologic or therapeutic effects. It is the purpose, here, to arrange the types in the manner that appeals most to the writer—i. e., distance from the sea—giving the climatic factors common to the various types. With this thought in mind, the following classification is presented:

I. Ocean.
- A. Sea voyages.
- B. Island.
- C. Coast.

II. Inland.
- A. Low altitude (up to 1,000 feet).
- B. Medium altitude (1,000 to 3,000 feet).
- C. High altitude (3,000 to 6,500 feet).
- D. Deserts.

The meteorologic factors of these different types will be taken account of as each group is considered in turn. The chief elements that give character to any distinct climate are temperature, the degree of moisture (for practical purposes confined to relative humidity), the wind conditions, and the atmospheric pressure. Among elements of minor import might be named the electric phenomena of the atmosphere. Other factors that have influence on the climate of small areas are the character of the soil, whether dry or moist, distance from or nearness to bodies of water, size and nature of forests, vegetation, density of population. Nonporous, damp soil may be detrimental, because by it the humidity of the air in such a region may be changed; too dry a soil, if there is much wind stirring, may not be beneficial on account of the dust produced; nearness of large areas of water changes the wind conditions. Large forests give protection against winds, and on the other hand, when coolness is needed, prevent the breeze from reaching the place. They are often a protection from dust and pathogenic organisms. Much vegetation produces humidity.

I. **Ocean Climates.**—Here temperature, according to latitude, varies less than with inland climates. The general characteristics and important properties of ocean climates are pure air and freedom from dust and pathogenic organisms; in general, they are moist and equable. The evenness of the temperature is characteristic; the difference of the temperature between day and night, for both summer and winter, is less than the inland climate, and in southern latitudes the temperature is

equable the year around, modified more or less by the Gulf Stream and other strong ocean currents.

The physiologic properties of the ocean climate, according to Schroeder and Blumenfeld ('04) show that the heart action is strengthened and that the pulse is slowed, for the moist air and air currents cool the skin and lead to the contraction of the blood-vessels. This, in turn, reflexly leads to increased heart action and dilatation of the blood-vessels of the skin, and finally to a cutaneous hyperemia. The ocean climates, in general, have a sedative and relaxing effect on the nervous system. The mucous membrane and skin are more active. The increased pressure leads to increased depth and slowing of respiration. The metabolism is considerably augmented, and, on account of the respiration, more carbon dioxid is thrown out. With this change of metabolism comes an increase of weight, and an increase of blood cells and hemoglobin.

This important effect on metabolism is a matter of individuality. Many persons, sick or well, who have made a change to an ocean climate, with whom such a climate agrees, may show just such results, while others will not improve at all in the same climate. Based on this adaptability of the individual to particular climates, Huggard ('06), in discussing types of climate, states that "the tonic or relaxing character of a climate turns chiefly on the ability of the organism to adapt itself to the requirements. Other things being equal, that climate is most tonic which demands the greatest amount of tissue change that a given organism can permanently yield." He shows that a climate that is tonic and stimulating to one person may be relaxing and sedative to another, and vice versa.

(*a*) *Sea Voyages.*—On a voyage with favorable weather conditions, one may, for a long period, experience the general characteristics of the ocean climate, receiving the benefit of outdoor life in the purest of air. On the other hand, the weather conditions may be unfavorable, with rain and high winds. In general, this type of climatic treatment is only applicable in the earliest stages of tuberculosis, when there are no constitutional symptoms, or for arrested cases. In both instances the patient should be proof against seasickness. The objections to ocean trips are that a sufficiently long voyage, under unfavorable weather conditions, may cause much confinement, and this, with the poor food too often found on the ships that go to semitropical and tropical countries, may cause disastrous effects. When a sea voyage can be made in a sanatorium ship, types of which have been constructed on the Continent, then such a sea voyage may be free from many of the drawbacks which ordinarily are a part of these voyages.

(*b*) *Island Climates.*—The climates of small islands possess practically the same characteristics as the ocean climate, and besides, persons

can be made more comfortable on an island and not suffer from seasickness. The smaller islands are not recommended for tuberculous persons, because of the disadvantage of poor accommodations and poor food, and isolation of the patient, which too often leads to nostalgia. One of the advantages of living on an island or on the coast is that sea bathing is possible, but this only applies to patients in the arrested stages of the disease, for those with active trouble should not bathe in the open sea. Sea bathing may be stimulating if not indulged in excessively. The first bath should be short, a mere dip of two or three minutes; longer bathing may cause much depression. If the limit of endurance has been exceeded, it will be marked by a chilly feeling, vertigo, or nausea.

The larger island, with mountainous districts, adds much to the scenic effects and beauty by presenting an elevated region in close proximity to the ocean, but the climate no longer partakes of the island character, but resembles more the ocean type.

(*c*) *Coast Climates.*—The coast region gives equable moist conditions, and practically offers the only ocean climate for selected, individual cases of tuberculosis. The atmosphere, most of the time, is cool and damp, often foggy, especially along the western coast of the United States and North Sea, Germany. Places with coast climate have the advantage of being accessible, and are often provided with suitable resorts, in which it is agreeable to live and where excellent accommodations may be found, with occasionally a sanatorium for the treatment of tuberculosis.

Many coast climates may be warm and moist during the summer months, depending on prevailing winds—the land and sea breezes—which make the climate equable. During the day the breeze blows from the sea to the land, and during the night from the cool land to the sea. The physiologic properties of the ocean climates, given above, apply especially to this type. The cases to be sent to such places should be individualized, just as for all other climates. The indications may be grouped as follows:

(1) The most favorable are early cases of tuberculosis without fever or marked constitutional symptoms. (2) Incipient cases with early and slight hemorrhages. (3) Chronic fibroid cases, with or without bronchitis or emphysema. (4) Old people with phthisis or a recurrent attack. (5) All cases complicated with cardiac or renal disease. (6) Young children with pulmonary or bone lesions. (7) Cases with marked nervous symptoms.

II. **Inland Climates.**—The temperature varies generally, according to the season, the distance from the ocean, and the proximity to the mountains, as well as the distance from the equator. In general, the mean temperature decreases with the distance from the equator. As the altitude increases the atmospheric pressure decreases, the humidity

lessens, the changes of temperature between day and night increase, and the sun's rays become more intense.

(*a*) *Low Altitude.*—Generally speaking, the climate in a low altitude is moist and cold in winter, moist and hot in summer, the mean temperature diminishing with the distance from the equator, being more equable according to the proximity of the ocean climate and drier according to the relative position of the mountains.

(*b*) *Medium Altitude.*—The climate here is warm, moderately moist in summer, cool and moderately dry in winter. In places where the rainfall occurs only in winter the climate is warm and moderately dry in summer, these factors being modified by local conditions such as forests, winds, soil, and vegetation.

(*c*) *High Altitude.*—Here purity of air is the dominant feature. The temperature is cool and dry in summer, especially in altitudes over 4,000 feet; cold and dry in winter, but modified by local conditions. The climate is characterized by the changes incident to diminished air pressure, by abundance of sunshine, snow, rain in showers, and electric storms in summer time. In former times ozone was considered an important factor. There seems now, however, no scientific evidence that ozone is liberated anywhere in such quantities as to be of special service.

The physiologic effects of the high altitude consist of an increase in the respiratory and cardiac functions and an increase in the appetite and general metabolism. Muscular power and the secretions of the mucous membranes are diminished. The nervous system is stimulated.

The effect on the blood has long been a matter of dispute. The blood-pressure is held to be decreased slightly (Huggard, '06). The amount of hemoglobin is increased. The white cells do not increase. That there is an increase in the number of red blood cells is acknowledged, but the question at issue is, How much is apparent and how much is real? The theories that have been brought forward to account for this increase are based either on changes in the peripheral circulation (Campbell and Hoagland, '02), by changes in the density of the blood (Grawitz, '95), by error in instruments used (Brünings, '03), and by changes due to the improved general health, either from a prolonged life of the red cells (Fick, '95) or by formation of new blood elements (Schaumann and Rosenquist, '97). There is, undoubtedly, some increase in the number of new blood elements formed, but hardly as great as the blood counts would indicate. It is an interesting fact that the increase in the number of red cells is most marked in the first few days, reaching its maximum in the first month, and then the number rapidly diminishes on descending to lower levels. Weinzirl ('03) has shown that cold is an important factor in the production of the blood

changes at high altitudes. It should be remembered also that stimulating climates other than those of altitude, through their effects on appetite and metabolism, lead to an increase in blood formation (Schroeder and Blumenfeld, '04).[1]

The stimulating effects of altitudes may, however, be dangerous in that the demand made on the respiratory, circulatory, and muscular apparatus produce a definite strain on the system, and if the patient is not sufficiently robust, or if he is injudicious in exercising before being acclimated, serious results may follow. In the selection of an altitude for cases of tuberculosis local conditions are as important as is the consideration of the constitutional symptoms.

Indications for high altitudes are: (1) Incipient cases, with or without fever; (2) cases beyond the incipient stage, with infiltration or beginning destruction; (3) cases with early hemoptyses or laryngeal cases; (4) cases with pleurisy or with old pleuritic exudate. Any of the above, with or without constitutional symptoms, are suitable for altitudes varying from 4,000 to 6,000 feet.

The *contraindications for high altitudes* are: (1) Too great an involvement or softening in both lungs; (2) cavity formations with much hemoptysis; (3) cases complicated with kidney or heart disease or diabetes; (4) cases with marked emphysema (asthmatics); (5) the very young tuberculous; (6) fibroid cases, with dyspnea; (7) advanced laryngitis; (8) excessively nervous patients.

The indications and contraindications enumerated above have the support of many authorities. There are various opinions for and against sending hemorrhagic cases to altitudes of over 2,000 feet, on account of the greatly diminished air pressure. The writer's opinion is that hemorrhage, of itself, is not a contraindication, except that in advanced cases, with frequent hemorrhages and cavity formation, with a history of much bleeding, medium and high elevations are not indicated. Campbell ('02) states that altitude does not apparently increase the mortality of hemorrhagic cases, but in his series of 250 patients the nonhemorrhagic cases had the advantage over the hemorrhagic in the improvement.

(*d*) *Desert Climates.*—To this type belong the inland climates of low and medium altitudes. A few desert places of value in the United States are below sea level. These are characterized by an abundance of sunshine, purity of air, low humidity, frequent winds and dust storms. The disadvantages of this type are the unpleasant winds, at times accompanied by much dust and sand, unsuitable accommodations, poor food, which often lead to nostalgia and mental depression.

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[1] The increase of lymphocytes in high altitudes as well as their effect in improving patients, noted by Webb and Williams ('09) should also be noted here.—Editor.

The *indications for desert climates* are: (1) Patients with complicating bronchitis and emphysema, especially those with abundant secretion; (2) albuminuria or kidney lesions; (3) far advanced cases and those of the third stage, that seem unfit for any other climate, may do surprisingly well.

From what has been said concerning the indications and contra-indications of climatic treatment, the results of such treatment are dependent not only on climatic elements, but on the individuality of patients. Schroeder and Blumenfeld ('04) summarize their view (see Table I, below) of this subject as follows: "There are climatic factors of eminent importance in the treatment of tuberculosis. We can find

TABLE I[1]

Comparison of Results in Tuberculous Treatment. (Summary)

Variety of Climate	Total Number of Cases	First Stage (Turban)	Second and Third Stages	Positive or Favorable Results	Negative or Unfavorable Results	Names of Resorts
Group A.						Madeira, Arcachon, West Riviera,
Sea Climate.....	3455	835	2620	2515	940	Entire Riviera, Norderney,
and						Danish Coast,
Coast Climate.....	....	24.7%	75.3%	72.8%	27.2%	Norwegian Coast, Sea Voyages.
Group B.						Grabowsee, Bedfort, Belzig,
Interior Land.....	3322	1221	2101	2815	507	Lohr, Altena, Engelthal,
Climate.....	....	36.7%	63.3%	88%	12%	Ruppertshain.
Group C.						
Altitude.....	3257	1222	2035	2856	401	Schoemberg, Friedrichsheim,
Climate up to 3,000 feet.....	....	37.5%	62.5%	87.7%	12.3%	Goerbersdorf, Albertsburg.
Group D.						
Altitude.....	2271	953	1318	1898	373	Neu-Schmecks, Davos, Zurich,
Climate above 3,000 feet.....	....	41.5%	58.5%	83.8%	16.2%	Asheville.

[1] These statistics are from Schroeder and Blumenfeld ('04) and show the results of treatment in sea and land climates of different kinds. In considering these figures, the difficulties encountered in making comparisons between patients in different stages must be kept in mind.

them on the seacoast, in the interior, in various levels above the sea. But there is no specific climate for phthisis. Only elements which assist our therapeutic endeavors are to be found in every climate of the moderate zone. In sea and altitude resorts they may act too powerfully and become harmful. The strictest individualization is therefore necessary when they are recommended. It ought to become the common property of all physicians that nothing can become more harmful to tuberculous patients than the routine belief in a specific influence on tuberculous processes through climate."

GENERAL UTILIZATION OF CLIMATIC TREATMENT

From what has been previously written in this chapter, it is evident that in choosing a health resort, the nonclimatic factors as well as the meteorologic elements must be considered. As there is no climate specially suited for all tuberculous patients, no simple rule as to the best climate can be followed strictly. Patients who do not react to the extra demands of a cold climate will do better in a semitropical region. For instance, young, robust individuals with tuberculosis, sent to a cold, dry mountain resort, will find living in the open air easier, and will have better appetite and digestion, and will improve more than the weak and old with a similar type of disease, these latter improving more in a mild, warm climate of lowered elevation.

In choosing a resort, the factors to be considered are:

1. Atmospheric conditions.
2. General topography.
3. Social environment.
4. Economic circumstances of the patient.
5. Psychic condition of the patient.

1. The elements of atmosphere in their relative importance are: (1) Purity of air; (2) percentage of sunshine; (3) pressure of air; (4) the amount of humidity; (5) the temperature and its variations, diurnal and otherwise; (6) the winds, their severity and whether laden with dust or other impurities.

2. In regard to the topography, the place (1) should have a dry, porous soil; (2) should be protected from strong winds by hills or forests; (3) should be free from dust; (4) have sufficient open grounds, and (5) a view and vegetation pleasing to the eye.

3. Under social environment are to be considered (1) the size and density of the population; (2) the general sanitation; (3) the restrictions and health rules governing invalids; (4) the number and extent of industrial activities, all of which may be factors in the making or marring of the climate of a resort.

4. The economic factor is a most important one, for the cost of living is everywhere increasing, and what were once considered luxuries are now placed among the comforts of life. Has the resort to which the patient is to be sent good accommodations? Suitable and hygienic houses and homes, where the proper food can be obtained, are also necessary, and for many patients light amusements and pleasurable diversions are additional factors. It must be known that good medical attendance can be had at all times. To obtain these ends the patient should be in command of sufficient money to give him the necessary comforts for at least one year.

5. The psychic element is by no means to be underestimated. The patient should strongly desire the life of the particular resort chosen, and be mentally in harmony with what such a climate offers. An element may act as a psychic depressant to one patient and have the opposite or no effect on another. It is easily comprehensible that continued cloudiness and fog is depressing, but a stronger psychic force is working when, as happens, patients find a cloudless climate and abundant sunshine monotonous and irritating. It is unwise to send patients to places where the surroundings produce depression. The psychic element in many cases is so strong a factor that it must be recognized and successfully met. The physician who individualizes most carefully will have the best results. He will not send a patient who has been used to comforts and luxuries to a climate meteorologically ideal where the surroundings are uncongenial, the accommodations meager, and the food poor; nor will he send an active, easily tempted temperament to an ideal resort where any phase of fast living is easily obtained.

H. P. Loomis ('06) has aptly put it thus: "Each case is to be studied, not as one having a certain disease which is ordinarily benefited by such and such a climate, but as an individual with distinct temperament, inclinations, and personal, peculiar phases of the disease."

Bullock ('02), in speaking on the same subject, writes: "So important do I consider the psychic status in any given case, that if a patient persists in a pessimistic viewpoint, occasion is taken to have a talk, the purport of which is that 'it might be better to go somewhere else'; for, without the coöperation of our patients, 'in spirit and in truth,' there is so little to be gained that the game is hardly worth the candle. . . . The psychic element in the treatment of the tuberculous is well illustrated by conditions at the government sanatorium at Fort Bayard. Patients are ordered there for treatment; the opportunity to get well is not sought, it is thrust on them. The régime at Fort Bayard, from a scientific viewpoint, is above criticism; nevertheless, because the patients belong to a class who do not appreciate anything forced on them,

no matter how good, the psychic state opposing rather than favoring recovery, the results will never be comparable to those obtained in an institution where the opposite state of mind prevails. In spite of this great disadvantage, the patients who have really appreciated the opportunity to get well have been sufficiently numerous to demonstrate beyond cavil the superlative advantage of a favorable climatic environment in the application of the principle of modern phthisio-therapeutics."

OPEN AND CLOSED RESORTS

For so long a time has climate been looked on as a factor in the treatment of tuberculosis that, according to the mode of life followed by the patient, the terms open and closed treatment have come into use. The closed resorts are those where patients avail themselves of the climatic treatment in institutions or sanatoria, and the open resorts those in which patients pursue the treatment outside of institutions—in homes or hotels or wherever they choose.

That the sanatorium, combined with climatic treatment, gives the best results for all early active cases is beyond question. Of the factors which help toward the good results of this combined climatic-sanatorium treatment, there is no doubt that the sanatorium methods—that is, the attention to diet, exercise, hydriatic measures, and regulated mode of life in the open air—have more to do with the good results obtained than anything in the climate itself.

In the early days of the sanatorium doctrine it was claimed that the tuberculous must be treated in such an institution, situated in some special climate. Later, as the results of sanatorium treatment in all kinds of climate became known, this view was modified, and it was claimed that all consumptives were to be treated in institutions, because proper modes of living were almost impossible in an open resort. This extreme view is to-day somewhat modified, for we have come to a more rational view in realizing that there can be no rule or dogma for all cases. We know now that some do better in the home, under suitable régime, and that others improve more in sanatoria, irrespective of climatic advantages or disadvantages.

It is to be remembered, however, that the attainment of the hygienic-dietetic and other needs enumerated are dependent not solely on the possession of well-constructed buildings in suitable places, but more on the guiding hand of the institution—namely, the medical director. The results will be largely dependent on him, while the grouping of buildings and patients enables him to carry out the work more easily.

Babcock ('07) says that without good accommodations and the attendance of skilled phthisio-therapists, the home climate, with all

its drawbacks of weather, is preferable, and again that the average physician is not sufficiently informed concerning the best methods of utilizing the home climate, or he will not take the trouble to so impress and instruct his patients that good results in the home may be rendered possible.

A change of scene is nearly always desirable for every consumptive, and such a beneficial change may be made by moving the patient to the top floor, to the roof, or by utilizing a porch, or by moving him from city surroundings to the suburbs or country. Such changes are all that can be had, for the present, by the great mass of tuberculous people, the majority of whom are poor, and who must have the best treatment at the least possible expense.

There is no rule for the rich. Cases must be individualized and treated according to the individual characteristics and requirements of the patients. For instance, given a group of rich patients, with each member of the group in approximately the same stage of the disease, some should be treated at home and others sent to a resort.

With our increased knowledge of the results of home treatment, some will do better in the home or in near-by sanatoria than in far-distant institutions, for the following reasons: At or near home such patients may be made more comfortable, have adequate accommodations, better food, be happier through nearness of family and friends, and be less depressed than if in the presence of sick people. The disadvantages of home treatment are that it is often difficult to control the patients and keep them to regular habits, and prevent the worry consequent on domestic and business cares. Frequently, too, the family becomes an obstacle to the desired ends through lack of coöperation with the physician.

In general, when patients have insufficient means to meet the extra demands of removal and the proper life in a suitable climate, it is best to have them remain at home, no matter what the local climatic conditions may be.

In sending a patient to a resort, the question naturally arises, Where shall he live? The large hotels are to be avoided, since they offer too great temptations for irregular habits and are less adapted for the outdoor life. Many of the large hotels also state that they do not receive tuberculous patients. What is meant, however, is that they do not accept, as guests, persons who are in the open stage of the disease. There is usually no objection to persons who have had tuberculosis and who have no bacilli-laden expectoration or show signs of active trouble. All these things considered, with our present knowledge of the correct régime for the tuberculous, it would seem best that the patient rent a house or go to a good boarding place, remaining under the constant super-

vision of a competent physician. Or when the health resort boasts of a sanatorium, the patient may enter such an institution. Whether a patient is to have institutional or noninstitutional treatment depends on the individual case, except that a patient who is always bright, cheerful, and sanguine is likely to do well in either location. The advantages to those who go to the sanatoria are that more often the patients there make a business of the treatment. It is easier to keep habits and rules because others are doing the same. The mental training, in the way of hope and encouragement, given to patients is also productive of great beneficial effects. The disadvantages of sanatorium life to not a few are the homesickness, the monotony of the food and care, and the depression caused by the presence of other sick people.

The advantages to many who live in the open resorts are: Freedom, through daily change of routine, which is always stimulating; the gratification of mental and physical tastes, and the greater variety of amusements and entertainments in their hours of exercise and rest (which, however, may work for good or harm), and the individual choice of medical attendants.

It will be understood from the foregoing that the decision as to the relative value of open and closed resorts is no easy one, since so many factors other than the purely climatic ones must be taken into consideration. Here, as elsewhere, statistics give only a limited viewpoint of the relative value.

Table I (page 689) gives the results of treatment obtained in different types of climatic resorts drawn from various sources, all but about one third of the patients belonging to the coast group, having been treated in closed institutions.

TABLE II

Results of Treatment in Insurance Sanatoria of Germany

Public in Closed Sanatoria	Favorable Results Able to Return to Work	Unfavorable Results	Total Treated	Percentage of Good Results	Percentage of Unfavorable Results
Tuberculous patients treated in—					
1898	3,623	1,287	4,910	73.8%	26.2%
1899	5,696	2,002	7,698	74%	26%
1900	8,037	3,057	11,094	72.3%	27.7%
1901	11,249	3,407	14,656	76.8%	23.2%
1902	12,885	3,604	16,489	77.6%	22.4%
Total	41,490	13,357	54,847	74.9%	25.1%

Table II presents the results of treatment obtained by the Insurance Sanatoria of Germany (Report '05), many of which institutions, for obvious reasons, are not located in the most favorable climatic environments.

Recently, Cornet ('07) has come forward and cited his own experience and that of other authorities (Koeniger, Hinsch) to show that the results are as good in the open as in the closed resorts, but his statements have already been questioned (Roepke, '07; Kraus, '07). Roepke, for instance, makes a careful analysis of the figures quoted by Cornet from Hinsch concerning the results of treatment at the open resort at the Lippspringe Bath, in the principality of Lippspringe, Germany, and after inquiry into some 974 cases treated in the open Lippspringe Bath resort, quoted by Hinsch, Roepke compares these with a series of 2,131 tuberculous patients treated at the *Auguste Viktoria Stift* Sanatorium, of the same place.

A summary of Roepke's results may be seen in the following figures:

TABLE III

	Stage I	Stage II	Stage III
Number treated at open Lippspringe Resort	859 (88.2%)	99 (10.2%)	16 (1.6%)
Number treated at *Auguste Viktoria Stift* Sanatorium at Lippspringe	631 (29.6%)	938 (44.0%)	562 (26.4%)

RESULTS

Results of Treatment at Open Lippspringe Resort	Stage I	Stage II	Stage III	Total
Complete recovery	376 (43.8%)	21 (21.2%)	0 (0%)	397 (40.8%)
Partial recovery	478 (55.6%)	75 (75.8%)	12 (75%)	565 (58.0%)
Negative	5 (0.6%)	3 (3.0%)	4 (2.5%)	12 (1.2%)
Results of Treatment at *Auguste Viktoria Stift* Sanatorium				
Complete recovery	437 (69.2%)	430 (45.9%)	29 (5.1%)	896 (42.0%)
Partial recovery	181 (28.7%)	428 (45.6%)	299 (53.3%)	908 (42.6%)
Negative	13 (2.1%)	80 (8.5%)	234 (41.6%)	327 (15.4%)

As regards the interpretation of the above figures, to use Roepke's own words, "that is, the number of first-stage patients treated at the Lippspringe Bath (open resort) are three times as great as at the Sanatorium (closed resort). The number of second-stage patients

treated at the Lippspringe Bath is four and a half times less than those treated in the *Auguste Viktoria Stift* Sanatorium; and yet, in spite of the much worse material at the sanatorium, the results of treatment were much better than at the bath."

Concerning the criticism of the German sanatoria by Cornet, the opinion seems to be that he has somewhat overdrawn the picture. It is true that these institutions have cost an enormous amount of money and the permanent results obtained have been less than has been desired, but the great educational value of such institutions and the real benefit derived by hundreds of the patients treated should stand as sufficient reward for the efforts expended.

THE SELECTION OF A SPECIAL CLIMATE OR RESORT

From what was said in the section dealing with the general utilization of climate, it will be understood that not only are the meteorologic conditions to be considered in the selection of a health resort, but the social conditions also. Patients with limited means are not apt to do as well in distant resorts as those who can purchase the comforts needed. It must be remembered that the climatic advantages of particular resorts are apt to be magnified by those who are interested in their success. On the other hand, the patient must be told that every climate has, at times, some unpleasant weather. Here, as in many other things, experience is often the best teacher. To know a climate and its therapeutic advantages, the meteorologic and social conditions must be studied, and this often cannot be done in less than several months.

Speaking generally, the high, dry climate, with freedom from wind storms, where snow and rain come in showers, and which possesses the greatest possible amount of sunshine, is recognized as the best place for uncomplicated cases of pulmonary tuberculosis. It is unfortunate that such climates are not more equable than they are, but equability is a factor usually found associated with moist climates.

The indications and contraindications for different types and degrees of pulmonary tuberculosis, which were presented in the section dealing with types of climates, suggest to what extent the physical condition of a patient may influence the selection of a special resort.

In addition to possessing the advantages due to changed meteorologic conditions, a proper resort should have suitable accommodations for leading the out-door life, and should have good food and pleasant surroundings. Under such conditions, with freedom from business and home cares, and with the mental and physical stimulation from the changed surroundings which the patient is given, there should then be,

with proper medical supervision, a fair chance for improvement. If the patient pursues the climatic treatment in an institution, he learns, in addition, while caring for himself and watching others, what is the best mode of life to follow.

Some of the disadvantages of going to a distant resort are the great expense involved, the long journey, the temptations created by too great an amount of amusement or exercise, and the fact that often the place chosen is not the one most needed by the patient. This last fault, however, may often be laid at the door of the physicians who, owing to their own lack of knowledge of the subject, give their patients most indefinite directions as to where to go. Another disadvantage is that the patient, after undergoing a course of treatment, finds he cannot return to his former home because of the great difference in climatic factors.

With regulated methods, the good results of treatment of incipient cases at a suitable climatic resort should be at least ten per cent higher than in closed sanatoria in the damp, changeable climate of the East, Gardiner ('01) placing the figure at fifteen per cent.

Henry ('06), in discussing types of climate from the standpoint of temperature, gives the following grouping:

"Classifying as warm those regions having an annual mean temperature of 60° [F.] and above, it will be found that such regions embrace the southern portion of North Carolina, South Carolina, Georgia, Florida, the Gulf States, the southwestern portion of New Mexico, southern Arizona, and the greater part of California, excepting, of course, the mountain districts.

"Classifying as temperate those regions having an annual mean temperature between 50° and 60° [F.], it will be found that such regions embrace the greater portion of the Middle Atlantic States, the Ohio Valley, Tennessee, the southern portions of Indiana and Illinois, all of Missouri, Kansas, Oklahoma, and southeastern Colorado.

"Classifying as cold those regions having an annual mean temperature of 40° to 50° [F.], it will be found that such regions embrace the northern tier of States, including the northern portion of Indiana, Illinois, all of Iowa, Nebraska, South Dakota, Wyoming, and the mountain districts of the West."

The classifications of resorts according to distinguishing meteorologic factors are always imperfect and unsatisfactory, but in keeping with the usual vogue such a grouping is here presented:

Cool and moderately moist: Canada, Adirondacks, Catskills.

Cool and dry: Colorado; higher altitudes of New Mexico, and a few in Arizona; high altitudes of the Alps, Engadine (Davos, St. Moritz).

Cool and moist: Coast of Maine; much of Canada; mountains of North and South Carolina and West Virginia.

Warm and dry: Medium and low altitudes of New Mexico and Arizona and western Texas; southeastern part of California; Mojave Desert; upper and lower Egypt, and mountains of South Africa.

Warm and moist: Florida, Bermuda, Madeira, Canary Islands, South Africa, and Southern California.

Warm and moderately moist: Most of South Carolina; Georgia; inland of Southern California; Riviera; southern Spain; north coast of Africa.

Warm and moderately dry: High elevated regions of Southern California, except southeastern part; northern and central Italy.

ENUMERATION OF RESORTS

The space allotted to this subject does not allow the presentation of the advantages and disadvantages of the large number of places in our own country and abroad which have become noted as resorts favorable for the treatment of pulmonary tuberculosis. The extent of the United States is so vast and the formation so great, with

TABLE IV

Cities	Altitude	Years of Weather Records	Mean Monthly Temperature												Mean Annual Temperature
			January	February	March	April	May	June	July	August	September	October	November	December	
Boston, Mass.	15	31	27	28	35	45	57	66	72	70	63	53	42	32	49
New York, N. Y.	37	33	30	31	38	48	60	69	74	73	66	56	44	34	52
Philadelphia, Pa.	42	31	32	34	40	51	62	72	76	74	68	57	45	36	54
Charleston, S. C.	11	33	50	52	58	65	73	79	82	81	76	67	58	51	66
Atlanta, Ga.	1,052	25	46	46	52	61	70	76	78	77	72	62	52	44	61
Pensacola, Fla.	12	24	52	56	60	67	74	80	81	82	78	70	60	54	68
New Orleans, La.	8	33	54	57	63	69	75	81	83	82	79	70	61	55	69
Galveston, Tex.	6	33	53	56	62	69	76	82	84	83	79	72	63	57	70
St. Paul, Minn.	758	31	12	16	29	48	60	67	74	72	62	50	32	20	45
Detroit, Mich.	593	33	24	25	33	46	58	67	72	70	63	52	38	29	48
St. Louis, Mo.	466	31	32	34	44	57	66	76	80	78	70	59	44	36	56
Cincinnati, Ohio	553	32	32	35	43	54	65	74	78	76	69	57	44	36	55
Memphis, Tenn.	268	33	41	44	52	62	71	78	81	80	73	63	51	43	62
Cheyenne, Wyo.	6,056	33	25	26	32	41	52	61	67	66	57	46	35	29	45
Denver, Colo.	5,219	31	29	32	39	48	57	67	72	71	63	51	39	33	50
Salt Lake City, Utah	4,293	30	28	33	42	50	58	67	76	75	64	52	40	33	52
Portland, Ore.	20	32	39	42	47	51	57	62	67	66	61	54	46	42	53
San Francisco, Cal.	28	32	50	52	54	55	57	59	59	59	61	60	56	51	56
San Diego, Cal.	40	32	54	55	56	60	62	65	68	70	66	64	59	56	61
Santa Fé, N. M.	6,180	30	29	32	40	47	56	66	69	68	61	51	39	31	49
Yuma, Ariz.	137	28	54	59	64	70	77	85	92	91	84	73	62	56	72

mountains, inland seas, deserts, various latitudes, and the two oceans, that any type of climate may be found. For a complete knowledge of the subject the reader is referred to the larger works on climatology.[1]

To show how widely meteorologic factors differ, the monthly and annual temperature means of cities in different sections of the country (Henry, '06) is herewith presented (Table IV).

These temperature means are the averages of observations taken by the United States Weather Bureau (Henry, '06) over periods of thirty years or more, and give somewhat of an idea of the temperature conditions met with in different parts of the country. Figure 175, showing the isotherms or lines of equal average temperatures for the year, presents similar knowledge in somewhat different form:

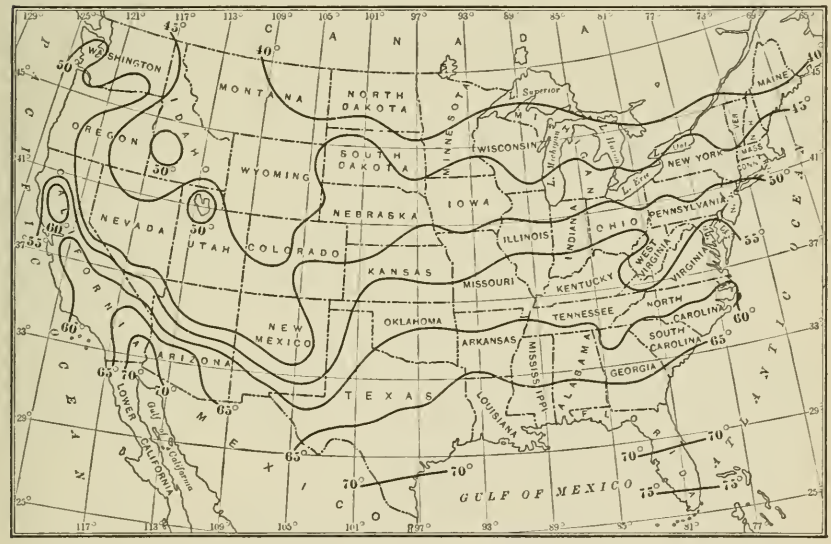

FIG. 175.—NORMAL SURFACE TEMPERATURE FOR THE YEAR IN THE UNITED STATES.

The following table (Fig. 176) shows the amount of rainfall by inches for the four seasons of the year for twelve different cities in the country, and enables one to note at a glance the difference in rainfall precipitation for these various regions (Henry, '06).

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[1] A very useful book in this connection is the "Directory of Institutions and Societies Dealing with Tuberculosis in the United States and Canada," published by the National Association for the Study and Prevention of Pulmonary Tuberculosis, and which contains a list, by States, of the sanatoria in the United States and Canada, and the capacity and charges of each.

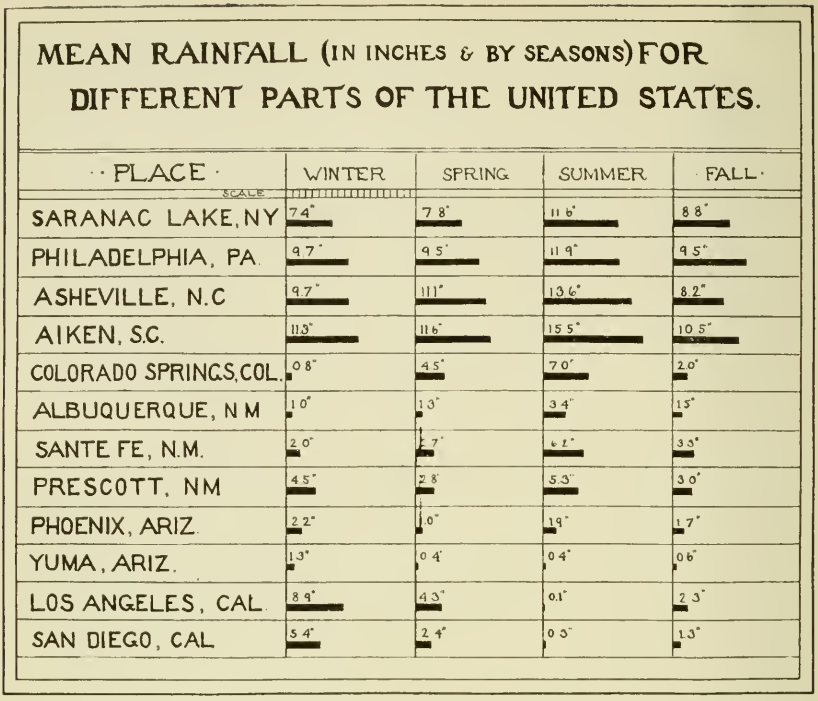


FIG. 176.—SEASONAL RAINFALL IN AMERICAN HEALTH RESORTS, COMPARED WITH PHILADELPHIA.

In the enumeration of resorts which follows, and which makes no pretense to comprehensiveness, our own country will be taken up first, various parts of the United States being considered in turn. Foreign resorts will also be discussed briefly.

UNITED STATES RESORTS

New England States.—Although one State in this section—*Massachusetts*—has been especially prominent in its official activities in the prevention of tuberculosis through its State sanatorium efforts, one would never send a patient to the New England States because of the climatic advantages there offered. The climate throughout the year is characterized by great changes of temperature and of the atmospheric conditions. The cold of winter and, except in the mountainous regions, the heat of summer, on the whole, render this region undesirable from the phthisiotherapeutic standpoint.

During the summer months, the interior portions of *Maine* and the White Mountains of *New Hampshire* present suitable conditions for

arrested cases, and for patients in the incipient stages without constitutional symptoms.

Maine presents attractive features to those wishing diversions, owing to its fine, large forests and many lakes, which make excellent hunting and fishing possible. More agreeable, during the summer, though not so beneficial to many patients, is its seacoast, the air being exhilarating even when fogs prevail. Along this coast may be found many pleasant places where the heat is never intense.

The Adirondack Mountains.—The northern part of New York State has an altitude of 1,500 to 2,500 feet. On account of the pioneer work of Dr. E. L. Trudeau, this section is internationally considered as a suitable resort for the tuberculous. The same cool and moist conditions prevail here as in the mountains of Maine and New Hampshire.

The good results obtained have been due, however, to the open-air treatment methods of Dr. Trudeau rather than to special climatic advantages. Purity of air is an important factor. The winters are cold, with much snow, when the air feels dry and bracing; the summers, in general, are cool, with much moisture. Oppressive heat occurs occasionally in summer, lasting, however, only a few days. As in all other eastern resorts, great changes of temperature take place. The region is studded with many small lakes, well wooded, and has an abundance of pure water. On the whole, the average weather is of the cool and cloudy kind, and one is stimulated by the crisp air.

The principal resort is *Saranac Lake*, and a short distance from it is *Trudeau*, where the Adirondack Cottage Sanatorium stands. Weather conditions of the four seasons covering a period of twelve years are as follows:

TABLE V

January 1, 1894, *to December* 31, 1903

Saranac Lake, N. Y. Essex County (Altitude, 1,620 Feet)	Mean Temperature	Mean of the Maximum Temperatures	Mean of the Minimum Temperatures	Mean Amount of Rain in Inches	Number of Days with 0.01 or More Rain	Average Depth of Snow	Direction of Prevailing Wind
Winter Mean.....	17	27	6	7.4	42	60.4	West.
Spring Mean.....	41	52	29	7.8	35	20.5	West.
Summer Mean....	64	75	52	11.6	36	0.0	West.
Fall Mean.....	45	55	35	8.8	35	10.7	West.
Annual Mean.....	42	52	31	35.6	148	91.6	West.

Adirondack Cottage Sanatorium (1,750 feet), some distance from the town of Saranac Lake, receives only incipient cases, and is intended only for poor people or those with moderate means, and all applications

have to be made through the town office in Saranac Lake. It is well protected from strong winds, and has a beautiful outlook. The accommodations include every comfort for the nominal sum of $5 a week. This institution is especially mentioned, as being one of the great achievements of Dr. Trudeau's life. By means of the results obtained in it and through his work in the prevention of tuberculosis, this great man has been an inspiration to a large number of men in similar institutions in our country. The work done by the Adirondack Cottage Laboratory, under the excellent guidance of Dr. Trudeau, has been as notable as the results obtained in the sanatorium.

There are excellent hotels and boarding houses in *Trudeau* where invalids are well cared for. Other resorts are *Paul Smith's, Lake Placid,* and many smaller places where good accommodations may be had. Around several of the towns and along many of the lakes camp life during the summer is made a very attractive feature.

Sea Breeze, near New York, with a typical eastern ocean climate, has shown what good results may be obtained at the seashore in the treatment of tuberculous diseases of children. That there is special value to be derived at the coast for children is now recognized. France was the first country to establish seaside sanatoria for children, and England has similar institutions. Brannan, in speaking of the effects of this climate on joint tuberculosis, writes: "The strengthening effect of the sea air was such that operations such as must constantly be resorted to in tuberculosis of the bones, joints, and glands, when patients live in cities, are rarely necessary. . . . Several patients who were unable to walk when they came, at the end of two or three months were able to run about and play with the others."

The senior surgeon of the institution, after fifteen years' experience, says that the knife plays a secondary part to climatic and general influences.

New Jersey.—The northern part of this State is more or less hilly and well wooded, and the towns are adapted for suburban residences. There are three places—Lakewood, Morristown, and Summit—that possess climatic factors for a winter residence to invalids who cannot go far from New York. *Lakewood*, altitude 60 feet, farther south, near the ocean, has sandy soil and a climate that partakes of the ocean climates. It is more equable, has a greater number of sunshiny days, and is well protected by pine forests. The season extends from October 1 to June 1. According to Schauffler's record for five years, the percentage of days with sunshine averaged eighty-four. The place is supplied with fine hotels, but is too fashionable to be a good resort for tuberculosis. *Morristown and Summit,* altitude 500 feet, and to the

northwest, are colder in winter and cooler in summer. They are quiet places, with comfortable homes, well suited for the outdoor life in an eastern climate.

Pennsylvania is another example of eastern climate. The weather conditions for Philadelphia, as a type, may be contrasted with others of the South and West.

The **Blue Ridge Mountain** region boasts of pure, comparatively dry air most of the year, with porous soil, but its resorts are better in winter, since the summers are usually hot. Among them may be mentioned *Delaware Water Gap*, altitude 600 feet, and *Glen Summit*, altitude 2,000 feet. Near the latter place, in *Luzerne County*, is the *White Haven Hospital*, for poor consumptives in early stages, with accommodations for 100 patients.

The following record for Philadelphia (Henry, '06) extends over fifty years:

TABLE VI

Philadelphia, Pa. (Altitude, 42 Feet)	Mean Temperature	Mean of the Maximum Temperatures	Mean of the Minimum Temperatures	Mean Amount of Rain in Inches	Number of Days with 0.01 or More of Rain	Average Amount of Snow in Inches	Relative Humidity 8 A.M.	Relative Humidity 8 P.M.	Average Hours	Percentage of Possible Sunshine	Wind
Winter Mean.	34	41	27	9.7	34	17.1	76	69	156	53	N. W.
Spring Mean.	51	60	42	9.5	36	4.1	70	64	224	55	N. W.
Summer Mean	74	83	66	11.9	32	0.0	73.	67	275	62	S. W.
Fall Mean....	57	64	49	9.5	28	1.0	77	70	203	60	N. W.
Annual Mean	54	62	46	40.6	130	22.2	74	67	215	57	N. W.

The Appalachians.—This chain of mountains, almost paralleling the Atlantic coast, extends from the New England States, on the north, to Georgia, on the south. The greatest elevations are in the southern part, and there the altitudes of the various resorts of this range are sufficient to lower the prevailing temperature in the warm season of the year. All along the Eastern States the elevated regions of this range influence the climate of that section, rising in New York to 4,000 feet in the Catskills, to 5,000 feet in the Adirondacks, and in New Hampshire to 6,000 feet in the White Mountains. In the south Atlantic States, *North* and *South Carolina* have many elevated regions on this range which climatically are well suited for the treatment of tuberculosis. The places vary from 1,000 to 3,000 feet in altitude, and are adapted for patients who may not be sent to high altitudes or too near the coast, or who cannot endure severe cold.

Great and sudden changes of temperature throughout the Appalachian range may occur at any season, as in other eastern climates.

Asheville, elevation 2,255 feet, with a population of about 20,000, is the principal resort of North Carolina, and is beautifully situated, being surrounded by hilly country and fine forests, which add much to its attractiveness. It has the general characteristics of mountain places, possesses a good climate all the year round, the summers being more equable than the winters. The summer is cool and comparatively dry, the mean of the maximum temperatures being 82° F., with relative humidity of 65° to 70° F., and an annual rainfall of 42 inches. The winters are cold, some days having frost and snow, which is light and disappears quickly. The mean of the minimum temperatures is 29° F., which gives a better idea of the winter range than the mean average. Excellent accommodations, several sanatoria, and plenty of amusing diversions may be had. A patient not accustomed to high altitudes, or one who may indulge in the outdoor life, should choose Asheville. The weather conditions of Asheville (Henry, '06) for twenty-four years were as follows:

TABLE VII

August 1, 1857, *to December* 31, 1903

Asheville, N. C., Buncombe Co. (Altitude, 2 255 Feet)	Mean Temperature	Mean of the Maximum Temperatures	Mean of the Minimum Temperatures	Mean Amount of Rain in Inches	Number of Days with 0.01 or More of Rain	Average Depth of Snow in Inches	Direction of Prevailing Wind
Winter Mean.....	39	50	29	9.7	27	14.8	West.
Spring Mean.....	54	66	43	11.1	32	1.5	West.
Summer Mean....	71	82	60	13.6	36	0.0	West.
Fall Mean.....	55	68	44	8.2	21	Trace	West.
Annual Mean.....	55	66	44	42.6	116	16.3	West.

Southern Pines, N. C., altitude 700 feet, a resort with the low inland type of climate, about 100 miles from the coast, is milder than Asheville and less stimulating. The winters are moderately cold, with some snow. The place is well protected from winds, and has a sanatorium for pulmonary tuberculosis.

Aiken, S. C., altitude 565 feet, is probably the most popular resort in the State of real value to the tuberculous. The variations of temperature and the relative humidity are less than in other sections of the State. The winters are mild and well known for the great number of sunny days. The town is well protected by forests, has limited accommodations and a sanatorium—the Aiken Cottages—for the poorer class.

The winter mean temperature is 48° F.; mean of the maxima, 56°

F.; mean of the minima, 39° F.; relative humidity, 65 to 69 per cent. Summer mean temperature, 78° F.; mean of the maxima, 86° F.; mean of the minima, 70° F.; relative humidity, 67 to 72 per cent.

Augusta, Ga., altitude 139 feet, and *North Augusta, S. C.*, separated by the Savannah River, which divides the two States, are climatically very similar, and resemble Aiken. Both are delightful places in which to pass the winter. North Augusta is about 500 feet higher than Augusta, and on account of this will be chosen by those who wish the increased elevation; otherwise the meteorologic factors are essentially the same.

Life in the open air may be followed advantageously, and is attractive in these places, with many amusements for those who have the time. The former drawbacks of these resorts—the inadequate accommodations and poor food for those seeking health—have been removed, and Coleman, who goes into details in regard to these places, says that one may now live and travel in luxury here as in any portion of the country (Henry, '06).

TABLE VIII

1875–1903

Augusta, Ga.	Temperature			Precipitation		Mean Humidity		Total Sunshine		Direction of Prevailing Wind
	Mean	Mean of the Maxima	Mean of the Minima	Mean.	Number of Days with 0.01 or More Rain	Relative, 8 A.M.	Relative, 8 P.M.	Average Hours	Percentage of Possible	
Winter Mean....	48	58	39	12.1	30	83	67	168	54	West.
Spring Mean.....	64	75	53	11.8	29	77	57	257	64	West.
Summer Mean...	80	90	70	15.4	36	82	70	322	76	S. E.
Fall Mean.....	65	75	55	9.2	21	84	69	228	65	N. E.
Annual Mean...	64	74	54	48.5	116	82	66	244	65	West.

In these warm and moderately moist places, patients in the early stages of tuberculosis, or in the fibroid stage, and those who do not bear altitude well, will find the winter very agreeable. The best season is from November to April.

Savannah, Ga., and *Charleston, S. C.*, have the warm ocean climates of the Atlantic coast, and on account of the disadvantages of large cities are not to be recommended.

Atlanta, Ga., altitude 1,059 feet, has an excellent climate of the low inland type. The best season is the spring—the months of March, April, and May—which is true of most of the southern climates, when the relative humidity is lowest. Occasionally it is very cold in winter,

as low as 5° to 8° F. below zero, and in summer may reach 95° F. For a period of ten years the mean temperature for winter was about 44° F.; for summer, 77° F. The mean relative humidity through the daytime for winter is 68 to 81 per cent; for spring it is 59 to 76 per cent; for summer it is 68 to 82 per cent, and for the fall it is 65 to 80 per cent.

Thomasville, Ga., altitude 330 feet, is a well-known winter resort. It is situated in the southern part of Georgia; it is warmer than the other resorts, and has a higher relative humidity, except in the winter time. The air is very mild throughout the winter and spring months, and suited to those who do not bear cold weather well. The spring often is warm, and the summer too warm for comfort. The mean annual temperature is about 67° F.; 53° F. for the winter and 81° F. for the summer.

Florida.—In general, the climate of Florida is equable, moist and warm. Florida has a peculiar, interesting scenery of its own, and the large resorts afford most excellent hotel accommodations. The resorts in Florida formerly were recommended for tuberculosis on account of the equable climate and because of the adequate accommodations. As the resorts in better climates have been made suitable and comfortable, fewer patients are being sent to Florida. Florida suffers less than most eastern places from the sudden changes, but cold waves occur during the winter, when the temperature may fall to the freezing point. The mildness in winter, the scenery, and the fine hotels are the chief attractions.

Jacksonville, St. Augustine, Tampa, and small places along the St. John River are favorite resorts for January, February, and March. The weather statistics for Jacksonville (Henry, '06) for thirty-two years are shown in the following table:

TABLE IX

1871–1903

Jacksonville, Fla.	Temperature			Precipitation		Mean Humidity		Total Sunshine		Direction of Prevailing Wind
	Mean	Mean of the Maxima	Mean of the Minima	Mean	Number of Days with 0.01 or More Rain	Relative, 8 A.M.	Relative 8 P.M.	Average Hours	Percentage of Possible	
Winter Mean....	56	65	47	9.4	27	84	76	163	51	N. E.
Spring Mean.....	69	78	60	10.4	24	78	70	281	71	N. E.
Summer Mean...	81	90	73	17.9	42	81	78	267	64	S. W.
Fall Mean.....	70	78	63	15.7	32	85	80	183	52	N. E.
Annual Mean....	69	78	61	53.4	125	82	76	223	60	N. E.

Rocky Mountain Resort Region.—This region comprises Colorado, Utah, New Mexico, the western part of Texas, Arizona, and a small strip of the eastern part of southern California. This whole region has similar characteristics, possessing dryness, elevation, and abundance of sunshine throughout the year. The air, on the whole, is nearly always stimulating and cool, except in certain parts of the southwest district, where the altitude is insufficient. So far as the climate is concerned, this whole region is a suitable and natural resort for those affected with pulmonary tuberculosis. For resorts having a high elevation, Colorado and New Mexico must be selected. There the winters are cold, with many days of low temperature. The southern parts of New Mexico and Arizona have warmer temperatures, with sites for ideal winter resorts, and are equable and dry and have many sunny days.

The eastern strip of California belonging to this region will not be considered, as it is uninhabitable and unfit, in its present condition, for resorts.

In the Rocky Mountain region rain falls chiefly in summer, in the form of showers which interfere little with the sunshine. In the southern part, from the continental divide east over the Colorado desert, through and including El Paso, rain falls in midsummer. This is in contrast to the Pacific Ocean region, where the rain falls in winter.

In the East and along the Atlantic coast the winters are rough and cold, while in the Rocky Mountain and Pacific coast regions the winters are warmer, more equable, and clearer. The reverse of this seems equally true, and although there are no statistics to offer, the writer's twelve years' experience on the Pacific coast has given him this impression.

The northern part of this region, especially Colorado, may be compared to the higher mountain resorts of the Alps, with the same indications for tuberculous cases, while the southern half—the arid district—has no similar continental region. The great advantage of the Alpine region is that the deep snow which covers the ground during the entire winter absolutely prevents any irritation of dust which is met with in so many other resorts.

Colorado.—The elevation of this State varies from 4,000 to 10,000 feet, with mountain peaks over 14,000 feet in height. Though there are many health resorts at different elevations, there are only a few to be mentioned that have gained great reputations.

Solly, J. E. ('07), states that "for the purpose of health resort stations the climate of Colorado may be divided into three groups: *First*, the prairie plains, ranging from 4,000 to 6,000 feet; *second*, the

foot-hills and adjoining valleys, varying from 6,000 to 7,000 feet; *third*, the natural parks, varying from 7,000 to 10,000 feet elevation."

Characteristic features of the State, besides the elevation and the great distance from the ocean, are low relative humidity, large range of temperature, and an abundance of sunshine, the prevailing winds being west. The climate of the eastern and southeastern parts is better than that of the western part. The mean temperature of the eastern section for winter is slightly above 30° F.; mean of the maxima varies from 40° to 49° F.; mean of the minima, 12° to 18° F.; mean for the summer, 70° to 76° F. Mean of the maxima in the southeastern part is 90° F.; 68° F. in the central part; mean of the minima in central mountain places is 61° to 35° F. The average relative humidity is 48 to 50 per cent. When high temperatures prevail, the humidity is very low. The average sunshine is from 65 to 75 per cent of the possible. From the above it will be noted that the summers are always cool and dry; the winters are cold, and, compared with other seasons, the greatest changes of temperature occur at that time. There are marked diurnal variations throughout the year.

The indications for the resorts of Colorado are those given for high altitudes. There is no better mountain climate than that of Colorado for pulmonary tuberculosis, or a climate that will agree with more patients. The objections are the occasional, severe cold, the sudden temperature changes of winter, and the strong winds of spring and fall.

Denver has an altitude of 5,183 to 5,600 feet. The business center is just one mile above sea level. Denver is an active, busy city, large and beautifully laid out, on the western edge of the great plains. It is the best known and principal health resort in Colorado. Its growth since 1875 has been tremendous, reaching now about 180,000, so that, on account of its size, it is now less suitable for many tuberculous patients than it was in former years. It has every advantage of a large modern city, with beautiful stone and brick residences, wide streets, and well-cared-for grounds. It possesses advantages over other places in Colorado in that one may find congenial companionship, earn a livelihood in a growing, busy city, or, after one is well enough, enter business life. This is not to be underestimated when one must change climates. On the other hand, it is not to be forgotten that it is often difficult for invalids, on account of the great demand for positions, to obtain suitable employment unless they have friends in the place to render assistance.

Advantages of Denver are (1) the good care and accommodations to be obtained; (2) the pure air, stimulating and cool; (3) the large amount of sunshine, and (4) the dry atmosphere. Objections are (1) the strong winds, with fine dust in the spring and fall, and, to young people, (2) the temptations of a large city.

The following weather statistics cover thirty-one years except the sunshine figures, which are for fourteen years, and the humidity averages, which cover fifteen years. During this time the lowest temperature of winter occurred in January (29° F. below zero) and in March (11° F. below zero).

TABLE X

DENVER

Records from January 1, 1873, to December 31, 1903

Seasons	Temperature			Precipitation		Mean Humidity		Total Sunshine		Direction of Prevailing Wind
	Mean	Mean of the Maxima	Mean of the Minima	Mean	Number of Days with 0.01 or More Rain	Relative, 8 A.M.	Relative, 8 P.M.	Average Hours	Percentage of Possible	
Winter Mean	31	44	18	1.7	15	59	49	200	69	South.
Spring Mean	48	61	35	5.4	26	63	39	266	65	South.
Summer Mean	70	84	56	4.4	25	63	34	296	68	South.
Fall Mean	51	65	37	2.2	14	57	35	243	74	South.
Annual Mean	50	63	37	13.7	80	61	39	251	69	South.

There are excellent hotels and good boarding houses in Denver, and several sanatoria. "The Home," near the center of Denver, is under the direct ownership and management of the Episcopal church of the diocese. The regular terms are $25 per week. The Agnes Memorial Sanatorium is situated in the suburbs; terms are $7 to $10 per week, with preference given to applications from western Pennsylvania. "The Associated Health Farm" was organized by the Young Men's Christian Association. There are several other institutions.

Colorado Springs, altitude 6,098 feet, is the next important health resort in the State. It is beautifully situated for a resort, being surrounded by high mountains, with the base of Pike's Peak six miles distant. It has a porous soil, an excellent system of drainage, a fine supply of water, a population, including suburbs, of about 42,000, fine wide streets and extensive grounds, which impress the stranger with the feeling that the open-air life is well carried out. The building of this town as a suitable resort is due largely to the help of General W. J. Palmer. It has all the climatic advantages of Denver, and in addition the open-air life of a distinct open resort is everywhere present with none of the disadvantages of a large city. Its most serious drawbacks are the excessive wind and dust storms, which prevail in spring and occasionally in the fall, against which invalids must be protected.

The temperature for the whole year is cooler than in Denver, the mean annual reading 47° F., as against 50° F.; the mean of the maxima is 60° F., as against 63° F.; the mean of the minima is 34° F., as against 37° F. This makes the warm months of spring, summer, and fall more agreeable, and for many temperaments Colorado Springs is much better than Denver. When snow falls in winter it does not remain on the ground for any length of time. The mean precipitation is about the same as in Denver—13 to 14 inches. Colorado Springs has fine hotel accommodations, and also many good boarding houses. The closed resorts have not been greatly developed. The one to be recommended for tuberculous patients only is "Craigmore," started by Solly and reopened this year, with excellent care and accommodations. Rates are $25 to $35 per week. The other institution recommended is "The Glockner Sanatorium," a sanatorium for all kinds of cases and not only tuberculous patients. Terms are $8 to $40 per week.

Manitou, altitude 6,300 feet, is five miles west of Colorado Springs, at the foot of Pike's Peak, and well sheltered from strong winds. The drives about Manitou and Colorado Springs are a most pleasing feature of this region.

Glenwood Springs, altitude 5,200 feet, is a summer resort for rheumatic and pulmonary invalids. It has a very comfortable hotel, but is not recommended as a resort.

Pueblo, altitude 4,700 feet, is a small manufacturing city which has mild and very dry winters, but very warm summers. There are few good accommodations, and it is not recommended as a resort.

Egeria, *Estes*, *Antelope*, and *Manitou Parks*, and *Palmer Lake*, all higher than Denver and Colorado Springs, are sheltered valleys, more or less known as summer resorts, and in some of them good board may be obtained (Solly (S. E.), '97).

New Mexico.—This State has an altitude from 3,000 to 5,000 feet, and extends from latitude 32 degrees to latitude 37 degrees. Most of the rain falls in summer, but only during a part of the day in July and August, so that throughout the year a large amount of sunshine is present, being at a maximum in the fall and winter. High winds are frequent in the early spring. The annual mean temperature is 54° F.; the winter average is 36° F. and the summer average is 72° F. The average annual precipitation is 13 inches and the mean relative humidity about 40 per cent.

The climate of the resorts in the northern part of the State is similar to the Colorado climate, but there are few good weather statistics for the different portions of the State. New Mexico possesses an excellent climate, adapted for an outdoor life during the whole year. The most serious objections to the climate are the severe winds in the early months

of spring, and in many places the lack of good accommodations and food.

Santa Fé (altitude 7,013 feet), *Las Vegas* (altitude 6,500 feet), and *Albuquerque* (altitude 5,200 feet) are three cities in the northern part of New Mexico, on the line of the Santa Fé Railroad, and are the best-known resorts. The climate of these places is very similar to that of Denver. Ten years' record of the weather bureau shows that the winter temperature in the above resorts does not fall so low as that of Denver, nor is the summer temperature as high. The humidity is less, and in Santa Fé there is less wind. An exception might be made of Las Vegas, the summer temperature of which is higher, though we have no proved record of the fact. Santa Fé, in a ten years' record, shows a winter mean temperature of 31° F.; summer, 67° F.; the lowest for winter is 13° F. below zero; the highest during summer is 97° F. The relative annual mean humidity is 55 per cent at 8 A.M. and 36 per cent at 8 P.M., with an average of 279 hours of total sunshine for the month. The prevailing wind is southeast, and is less intense during any part of the year than in either of the other places.

Las Vegas is warmer and dustier in summer than Santa Fé; has higher winds in spring, with much the same fine winter climate.

Albuquerque is warmer, both in winter and summer, than Santa Fé, has less precipitation, but has severer and more frequent winds. The mean temperature for winter is 35° F.; for summer it is 76° F. The lowest temperature is 10° F. below zero; the highest is 104° F. The prevailing wind is south. The annual mean rainfall is 7.2 inches, while Santa Fé has 14.2 inches. Albuquerque is a most thriving and progressive city, and better accommodations and food may be obtained there than in Santa Fé, but the climatic conditions are not so favorable. On account of the lower humidity and the greater amount of sunshine, these resorts would be better than either Denver or Colorado Springs if the climate alone were to be considered, but the resorts of Colorado possess the other factors so necessary in climatotherapy. There are sanatoria and limited accommodations at each of these three places.

The principal resorts of the southern part of New Mexico to be here considered—*Deming, Silver City, Fort Bayard*—are situated in the southwestern region. El Paso and Texas will be included with the others, as having similar climatic conditions and representing western Texas. Each has an ideal winter temperature, with as low humidity and as much sunshine as can be found anywhere in the Rocky Mountain region. Silver City and Fort Bayard, in summer, are comfortably cool, with few hot days, owing to the high altitude, while Deming and El Paso are too warm for comfort.

Deming, altitude 4,315 feet, is 250 miles south of Albuquerque;

has an ideal winter climate, but limited accommodations. *Silver City*, altitude 6,000 feet, is 50 miles northwest of Deming, and as comfortable a place for the tuberculous as will be found in this region, with a choice of three sanatoria, and here one may find comfort the year around. The mean annual temperature is 54° F.; the relative humidity is 46 per cent; the rainfall is 12.3 inches, with thirty-seven cloudy days in the year (Bullock, '02).

About seven miles from Silver City is the government sanatorium, Fort Bayard, for the officers and men of the United States army. The place was chosen as offering some of the best climatic advantages in the United States (Bessey, '03).

To contrast the weather conditions of the high and medium altitudes of this region, the statistics for Fort Bayard and El Paso (Henry, '06) are shown in the following tables:

TABLE XI
1895–1903

Fort Bayard, New Mexico Altitude, 6,040 Feet	Temperature			Precipitation		Average Depth of Snow in Inches	Direction of Prevailing Wind
	Mean	Mean of the Maxima	Mean of the Minima	Mean	Number of Days with 0.01 or More Inches of Rain		
Winter Mean	39	54	25	2.6	8	7.2	West.
Spring Mean	53	69	38	1.2	5	1.3	West.
Summer Mean	72	86	57	6.6	24	0.0	West.
Fall Mean	57	71	42	3.6	12	0.8	Southwest.
Annual Mean	55	70	40	14	49	9.3	West.

TABLE XII
1879–1903

El Paso, Texas Altitude, 3,702 Feet	Temperature			Precipitation		Average Depth of Snow in Inches in 24 Hours	Mean Humidity		Direction of Prevailing Wind
	Mean	Mean of the Maxima	Mean of the Minima	Mean	Number of Days with 0.01 Inches or More Rain		Relative, 8 A.M.	Relative, 8 P.M.	
Winter Mean	47	60	33	1.4	9	2	58	32	N. W.
Spring Mean	64	79	50	0.9	5	0.1	38	15	N. W.
Summer Mean	80	94	68	4.4	20	0.0	55	26	E.
Fall Mean	63	77	50	2.6	13	0.3	60	31	E.
Annual Mean	63	77	50	9.3	47	2.4	53	26	N. W.

Arizona has climatic advantages similar to those found in New Mexico. In general the winters are warmer, the summers hotter, and the mean humidity is less. The high altitudes have snow in the winter, and there is no section of the State entirely free from frost. Unlike New Mexico, the Pacific coast makes its influence felt here, and there are two rainy seasons, winter and summer, though the greatest rainfall occurs in July and August. The least precipitation is in the southern and southeastern part, amounting annually to less than three inches.

The advantages of Arizona are (1) pure air; (2) the great amount of sunshine; (3) the dryness; (4) the mild winters; (5) in the elevated regions of the northern half, cool summers; (6) few bad storms of any kind. Mean temperature is 60° to 65° F.; relative humidity, 30 to 50 per cent. This mean temperature gives little idea of the actual heat that exists in some places during the summer, when the temperature in the lower district is 110° to 120° F. At Fort Mojave a record of 127° F. was made in June, 1896.

The objection to Arizona is that it is lacking in modern towns or places where suitable accommodations may be had. In most of the towns it is almost impossible to get first-class food or care. Except in a few resorts, there is an insufficient water supply. Dust storms and high winds occasionally occur in spring. The summers are uncomfortably warm anywhere except in the highest altitudes.

Prescott, altitude 5,260 feet, and *Flagstaff*, altitude 7,000 feet, for all year round resorts are the two places recommended. Part of the summers may be hot, and the spring may have dusty days. The accommodations are not good in either place. Flagstaff is beautifully situated, having nearby forests of tall pines and many interesting cañons.

Of the lower elevations recommended for winter climates only, the principal resort is *Phœnix*, with an altitude of 1,087 feet. This town is favorably situated, and well known for its mild winters, low humidity, and large amount of sunshine. A distinguishing and valuable characteristic is the absence of wind and dust storms. Here suitable accommodations may be had, and good care is given to the invalid; but the place is not prepared to care for a large number, and arrangements had best be made before going. *Tempe*, near Phœnix, has the same climatic advantages. *Tucson*, altitude 2,400 feet, in the southwestern part of the State, has an ideal winter climate, and can be recommended from December to April. The accommodations have improved in the last few years, and patients needing this medium altitude always improve.

The following tables for Phœnix and Prescott, types of low and high altitudes of Arizona, are here given:

TABLE XIII

PHŒNIX, ARIZONA. ALTITUDE, 1,087 FEET

Record from January 1, 1896, *to December* 31, 1903 (Henry, '06).

SEASONS	TEMPERATURE			PRECIPITATION		HUMIDITY		Direction of Prevailing Wind	Percentage of Possible Sunshine	Average Hours Sunshine
	Mean	Mean of the Maxima	Mean of the Minima	Mean	Number of Days with 0.01 Inches or More Rain	Relative, 8 A.M.	Relative, 8 P.M.			
Winter Mean.....	53	66	39	2.2	9	61	32	E.	79	243
Spring Mean.....	67	82	53	1.0	5	45	19	E.	85	338
Summer Mean....	88	102	74	1.9	12	45	19	E.	86	369
Fall Mean.....	72	86	57	1.7	8	53	28	E.	86	297
Annual Mean	70	84	56	6.8	34	51	25	E.	84	312

TABLE XIV

PRESCOTT, ARIZONA. ALTITUDE, 5,260 FEET (HENRY, '06).

Record from 1876–1903. (*Irregularly.*)

SEASONS	TEMPERATURE			PRECIPITATION		Average Depth of Snow in Inches	Relative Mean Humidity, 8 A.M.	Direction of Prevailing Wind
	Mean	Mean of the Maxima	Mean of the Minima	Mean	Number of Days with 0.01 Inches or More Rain			
Winter Mean.....	37	50	23	4.5	15	13.2	58	S. W.
Spring Mean.....	50	67	36	2.8	11	7.4	47	S.
Summer Mean.....	60	86	55	5.3	23	0 0	49	S. W.
Fall Mean.....	53	70	38	3 0	11	1.8	50	S. W.
Annual Mean.....	52	68	38	15.6	60	22.4	51	S. W.

There are places in Arizona and in southern California, east of the coast range, that are above and below sea level, and as dry as any places where there is abundant sunshine. These are really desert climates, examples of which are *Yuma*, Ariz., with an altitude of 140 feet, and *Palm Springs*, Cal. It is unfortunate that there are few accommodations for invalids, and that the summers are intensely hot.

California.—The northern part of California (McAdie, '02) is mountainous and picturesque, with much moisture for the abundant vegetation that is present. It is mostly uninhabited, and in general unsuited for tuberculous patients except for two or three months in the summer. At that time of the year the elevated parts in the Mt.

Shasta region are cool and invigorating. These mountainous districts are only used as a sojourn for summer outing by a few patients who need a cool, elevated place as a change from the inland regions or the warm places of southern California.

Southern California (Edwards, '02)—that is, the part of the State bounded on the north by the mountains which meet the coast at Point Conception, above Santa Barbara, and on the east by the coast range—is the region which mostly concerns the phthisiotherapist. All of this district partakes, more or less, of a coast climate, modified by nearness to the Colorado desert and Arizona. Places on the coast and up to 1,000 feet elevation are cool, moderately moist in fall and winter, warm and moist in spring and summer. The afternoons are always less moist than the mornings, and approach relative dryness. Inland 60 miles, or at about 1,000 feet elevation, it is warm and moderately dry in winter, hot and moderately dry in summer.

Although it is said with truth, owing to the diversified topography, that slight changes of location may give one a very different climate, it is impossible to live in any degree of comfort in many of the regions. Some have no accommodations, others no suitable food, and others no vegetation of any kind. Practically, the regions where one can find comfort, contentment, and happiness throughout the whole year are along or near the coast, and these regions are not as desirable climatically for tuberculous patients. The humidity is fairly—that is, moderately—high, and is increased by the rainy season in winter and by the fogs in the dry summer season.

The fog formation along the Pacific coast has always been considered peculiar, and is especially frequent in the spring and summer within 40 miles of the coast. This interferes somewhat with the amount of sunshine, although the high fogs usually disappear before noon. The weeks that occur without fogs are uncomfortably warm, and occasionally there is a hot, dry wind from the northeast, laden with fine dust. On the whole, the climate for the year is more equable and comfortable than other coast climates in the United States, with cool nights throughout the year. Thunderstorms or strong winds are comparatively rare and never severe. There is a cooling breeze from the ocean by day, and from the mountains by night. California is soothing, while Colorado is stimulating (Fisk, '01). The indications for sending patients to this region are those given under Coast Climates.

Los Angeles, altitude 287 feet, is about 15 miles from the coast, and is well known as the metropolis of southern California. It is as attractive as any city of like size in the western country. Its population in the past ten years has more than doubled; in 1907 it was 280,000. It is well supplied with all the attractions and comforts of a modern city.

Its great development in the past few years has gradually lessened its desirability as a health resort. The dust and dirt have increased with the growing industries. Eastern people, once visitors, often settle permanently. It is more difficult than formerly to get accommodations for tuberculous patients. At present it is best to send patients to the foothill districts and the sparsely settled inland places, where the humidity is somewhat less and the air free from dust and contamination. Like Denver, however, a person recovering from tuberculosis near this region has the advantage of being able to enter business life.

Pasadena, altitude 800 feet, is nine miles northeast of Los Angeles, and more suitable for winter residence. This town, too, is rapidly growing out of the resort class, but its outlying districts are still well adapted for open resort treatment. It is one of the most charming residential places on the continent, with beautiful homes and well-kept grounds. Tuberculous patients who come to southern California will, as a rule, do better in the foothill regions of Pasadena and the San Gabriel Valley, up to and including Riverside and Redlands. Places along this region vary from 800 feet to 2,500 feet, and the farther away such places are from the ocean the less fog and the more heat.

Suitable places are *Altadena, Sierra Madre, Monrovia, Ontario, San Bernardino*, and *Redlands*. The first four are comfortable throughout the year, with some hot days in summer. Altadena and Monrovia are each supplied with an excellent sanatorium. Riverside, San Bernardino, and Redlands are suitable winter resorts, but too warm in summer. Of all these places, Redlands, altitude 1,200 feet, has the best winter climate, with good accommodations for incipient cases. It is difficult in any California resort to get accommodations for advanced patients. The climatic conditions are such that one can live outdoors with comfort, day and night, the year around, and be comfortable under blankets every night of summer.

The weather statistics of Los Angeles (Henry, '06) will serve as a guide for this region. (See Table XV.)

San Diego, altitude 40 feet, has the warmest winter and coolest summer of any town in southern California. The humidity is, however, higher than in the inland regions, though the mean temperature, compared with Los Angeles, is nearly the same. The absolute minimum temperature for San Diego during the winter is 32° F.; for Los Angeles, 28° F., and the absolute maximum for San Diego in summer is 94° F.; for Los Angeles, 106° F. The relative humidity, compared with that of Los Angeles, is high—80 per cent A.M. and 75 per cent P.M. This difference is about the same for all seasons, though the rainfall is much less. There are few places for tuberculous patients in San Diego, and one had best make arrangements before going. The country

TABLE XV

1877–1903

Los Angeles, Cal. Altitude, 287 Feet	Temperature			Precipitation		Mean Humidity		Percentage of Possible Sunshine	Direction of Prevailing Wind	Average Hours of Sunshine.
	Mean	Mean of the Maxima	Mean of the Minima	Mean	Number of Days with 0.01 Inches or More Rain	Relative, 8 A.M.	Relative, 8 P.M.			
Winter Mean....	55	66	45	8.9	18	67	64	74	N. E.	227
Spring Mean....	60	70	49	4.3	14	83	64	66	W.	263
Summer Mean..	70	82	58	0.1	1	88	62	74	W.	319
Fall Mean.....	65	77	52	2.3	6	75	65	77	W.	263
Annual Mean...	62	74	51	15.6	40	78	64	73	W.	268

districts back of San Diego are attractive climatically, and one can find mountain places (Julian) up to 5,000 feet, but they are too primitive for tuberculous patients.

Santa Barbara, altitude 130 feet, has much the same weather conditions as San Diego, though not so equable; the winters are slightly colder and the summers warmer. There are often severe winds from the ocean, and altogether the place is inferior to San Diego. In other ways, however, this town is the most attractive place on the coast, and gives excellent accommodations. The nearness of the mountains to the ocean makes a picture unsurpassed in southern California. One may live at Santa Barbara, near the ocean, at an elevation of 800 feet. The disadvantages are the fogs and winds. There are places in the foothills near Santa Barbara (Ojai Valley) which are protected and more suitable for consumptives, but the accommodations are poor and the food is bad.

FOREIGN RESORTS

Mexico.—From a climatic standpoint, the mountain regions of Mexico are more suitable for lung cases than southern California. The winters are dry, mild, and agreeable, with much sunshine. In the elevated regions, *Mexico City* (7,215 feet) and *Guadalajara* (5,100 feet) are the two places most suitable for Americans, where, on account of the size of the cities, comforts may be obtained. Contrary to the general impression, the summers are more agreeable than the winters.

The chief objections are the trip to and from Mexico, the difficulty in obtaining suitable accommodations and food, and, in many places, the unsanitary surroundings.

Canada.—The Canadian Rockies and British Columbia (Hinsdale, '02) have a boldness of scenery unsurpassed in this country, and might be said to resemble the Alps. The summers are cool, dry, and bracing, and the region has the advantages of a mountain climate, but is too extreme for winter residence. Its great disadvantages are the difficult transportation and no winter accommodations.

In *Ontario* the climate is influenced by the Great Lakes, and it is cool and moist through the summer; the winters, though intensely cold, are relatively dry, and the sharp changes met with in the United States are wanting.

Gravenhurst is a favorite resort for the tuberculous, and near it is situated the well-known Muskoka Cottage Sanatorium, altitude 800 feet, established in 1897.

Madeira, an island 350 miles from the northwest coast of Africa, long considered the best winter place for tuberculosis, is an example of an island type of climate, being more equable and drier than is usual. It is no longer a favorite resort, except for those needing such a soothing, relaxing atmosphere. Its great charm is the beauty of its scenery, and the mild climate, free from winds and dust.

Canary Islands.—These islands are 200 miles south of Madeira, are warmer, have more wind and dust, but otherwise the climate is similar to Madeira.

The indications for all these coast regions are those given previously under Coast Climates.

Europe.—The *Alpine region* has acquired the greatest reputation for the altitude treatment of tuberculosis. The best known and most important resorts are *St. Moritz* (altitude 6,000 feet), *Davos-Platz* (altitude 5,352 feet), *Arosa* (altitude 6,100 feet), and *Leysin* (4,700 feet). *St. Moritz* (Klebs, A. C., '06) and *Davos* have the greatest reputations, and are noted for their stimulating effects and general attractiveness. Both can boast of fine, pure air, great dryness, cold winters and cool summers, with freedom from strong winds and dust storms. Patients who can go to this climate make the greatest gain in the dry, cold, stimulating air of winter. Indications are the same as for the high altitudes of the Rocky Mountain region.

The resorts along the European coast are so numerous that space permits but brief mention of a few of the better known. The French and Italian Riviera are favorite winter resorts, especially for English people. They are protected on the north by mountains, and the air has an agreeable, soothing effect. The French Riviera is less protected from cold wind than the Italian Riviera. The contrast of the blue sea near the high mountains is not unlike a few spots on the California coast. One must expect rain in the season—twenty-five to thirty days—

from November to April. The rain often comes in showers, leaving the sky clear and blue. *Cannes, Monte Carlo,* and *Nice* are most expensive; the social life and amusements are too great temptations for those seeking health. *Nice* is the largest town, and less attractive than *Cannes. Mentone* is warmer in winter, better protected from wind; a quiet, dull place, and better suited for patients. *Bordighera* and *San Remo,* on the Italian Riviera, have the same advantages for the invalid as *Mentone,* but are more attractive, and are growing in fame as health resorts.

Southern Spain has several resorts climatically similar to the Riviera; they are less frequented, but some find them more agreeable.

For inland climates of medium altitudes, suitable for consumptives both winter and summer, some of the *German* resorts may be particularly mentioned, these places having gained their fame largely from the excellent sanatoria established there. Of such resorts may be mentioned *Goebersdorf* (altitude, 1,700 feet), where Brehmer established his sanatorium in 1859; *Falkenstein,* which his pupil, Dettweiler, made famous; *Hohenhonnef* and the Black Forest region, with Walther's colony at *Nordrach, Wehrawald, Schömberg,* etc. In the south of France are to be found *Pau, Biarritz,* and others.

Russia.—In Russia, a good winter climate is found in *Yalta,* on the southern coast of the Crimea, which is well protected by hills and resembles the climate of Madeira, but is too warm in summer. For tuberculosis the year round the inland climates situated in the Caucasus—*Abbas-Tuman* (altitude 3,505 feet) and *Borjon,* with excellent hotel accommodations—are popular.

Africa.—In this country two regions offer advantages—Egypt and South Africa. Egypt offers a dry and equable climate, but suitable only in the winter season—from December to May. The region from Cairo to Assouan offers the best accommodations. Near Cairo the rainfall is very slight throughout the year. In lower Egypt, *Helouan,* near Cairo, is a desirable resort. In upper Egypt are *Luxor* and *Assouan,* the latter being drier and more healthful than the Cairo region, and being also the cleanest, driest, warmest place in all Egypt. The mosquitoes and flies are the great drawbacks in Egypt, especially in the spring.

South Africa.—The southeastern coast is the best known portion, April to October corresponding to the winter or rainy season. Resorts which may be mentioned are *Durban* on the coast, *Cape Town* and the *Transvaal* in the interior. *Johannesburg* (altitude 5,689 feet) and *Pretoria* (altitude 4,471 feet) have dryness, but dust storms are not infrequent. Many of the places are handicapped by bad sanitary conditions and poor accommodations and food.

ADDENDA

Summary of Climatic Treatment Presented at the International Congress, held in Washington, D. C.

No important changes in climatic therapeutics were introduced or presented in the papers of the International Congress on Tuberculosis. Much of the ground covered in the previously written chapter on Practical Climatic Therapeutics was given and discussed in various ways, with no different results than those already shown. A few whose time was devoted to the effects of climate—men such as Knight, of Boston, and Williams, of London—advocated climatic treatment by change of climate under proper conditions. The great benefit derived from change of scene and surroundings is part of climatic treatment. Again, it was noted that there is no specific climate, and the keynote was struck in saying that each case should be a law unto itself, always to individualize —that is, to obtain for each case the best climate available. In the modern treatment of tuberculosis, whether a patient is home or abroad, and whatever the meteorological conditions may be, climatic treatment is an important therapeutic agent. The majority of the members agreed that most patients do better away from home, uninfluenced by home surroundings and the kind but usually misdirected advice of the family. Especially was this emphasized by Minor, of Asheville. In choosing a suitable climatic place, the nonclimatic factors must be considered; whether the patient should have sanatorium or home treatment depends much upon the individual and the medical attendance obtainable.

Carrington, of New Mexico, showed that while the southwestern localities have some provision for the care of the tuberculous, few have adequate provision, and practically no charitable institutions. He cautioned physicians against sending indigent consumptives to the southwest.

In the true climatic sense, the high-altitude treatment received great impetus from this Congress, as accomplishing the greatest good for the largest number. At high altitudes the great number of clear, bright days through the year, even in the winter time, was emphasized, as well as other advantages previously enumerated by the writer. The high-altitude treatment is most successful in early cases and those with consolidation. It stimulates the whole system, lessens the clinical symptoms, and brings an increase in weight. In speaking on altitude, Williams said that climatic treatment of itself, without hygiene, was known to be the cause of recovery, especially in the instances of patients living in high altitudes of the Andes and Alps. It was urged that the tendency to hemorrhage is no contraindication for high altitude, except when due to increased blood-pressure; nor is fever a contraindication, except in cases of rapid pulse and heart action.

PART VI

SURGICAL TUBERCULOSIS

CHAPTER I

TUBERCULOSIS OF THE LYMPH GLANDS

By LEONARD FREEMAN

This form of tuberculosis is often regarded as conservative, because the arrest of tubercle bacilli in the lymph nodes may prevent their penetration to more important parts. Although nodes in almost any portion of the body can become affected, the disease usually appears in certain definite regions, such as the neck, groin, axilla, mediastina, and abdomen. The trouble nearly always arises from some neighboring focus with which the nodes are in immediate relation, although cases are occasionally seen in which infection seems to have traveled through the blood from a distant part. It should be noted that the primary focus may be comparatively trivial while the glandular involvement is extensive.

Section of a diseased node generally reveals nodules of some size which are formed from a conglomeration of smaller tubercles, and are often caseous (Plate III). Softening of these caseous areas is common, and the entire gland may thus be transformed into a tuberculous abscess confined within the more or less dilated and thickened capsule. Occasionally calcification or the development of fibrous tissue may lead to an arrest of the process. It is claimed that in rare instances hyperplasia of the nodes occurs without the development of definite tubercles, producing a condition closely resembling Hodgkin's disease. There are even those who regard Hodgkin's disease as a manifestation of glandular tuberculosis, but this view is not generally accepted.

As the trouble progresses the glands increase in size, often becoming as large as walnuts. There is a tendency toward progressive infection of neighboring nodes in the direction of lymphatic circulation, which may lead to the involvement of an entire region—for instance, the cervical or the inguinal. If the glandular capsule gives way, tuberculous periadenitis results, implicating the surrounding connective tissue and causing extensive adhesions to adjacent structures, such as blood-vessels, nerves, and muscles. This process is sometimes so extensive as to produce large indurated areas, in which are embedded numerous caseous and purulent glands.

Involvement of the skin is frequent, as is also the formation of sinuses, through which are discharged the contents of nodes. The skin presents a dark red or livid hue, and when it breaks down, as it is apt to do about the mouth of a sinus, the edges of the resulting indolent ulcer are undermined and ragged. If healing occurs, a white, puckered, and disfiguring scar remains, as is so often seen about the neck. The sinuses leading to tuberculous glands are notoriously chronic and hard to cure.

Although the *lymph channels* leading from one gland to another are often tuberculous, this is usually lost sight of in the general involvement of the tissues. Rarely the cutaneous lymphatics become diseased, especially those of the forearm, following tuberculous infections of the fingers (so-called anatomic tubercles). Caseous nodules then result, distributed along the course of the lymphatics, which may break down and cause ulcerations of the skin.

The presence of the tuberculous virus can always be demonstrated by animal inoculation, but it is generally difficult and sometimes impossible to find the tubercle bacillus with the microscope; hence the failure to do this should not be given too much weight in the diagnosis. The tuberculin test is fairly conclusive, providing a focus of disease does not exist elsewhere, which, however, cannot always be determined with certainty.

Tuberculous lymph glands are liable to mixed infection, especially with the ordinary pus-forming microörganisms, which often leads to inflammatory swelling, accompanied by pain, tenderness, and the general symptoms of sepsis, thus obscuring the real origin of the trouble.

Etiology.—Most cases of tuberculous adenitis, particularly the cervical form, develop in the young under bad hygienic surroundings—in the slums, tenements, and sweatshops of large cities, and wherever people are overcrowded, overworked, and underfed, with lack of sleep, fresh air, and sunshine—but this is not always the case, as the disease is frequently enough met with in children reared under the best possible conditions. A weak resisting power may also be due to heredity or brought about by one of the acute infectious diseases, especially measles or scarlet fever. Occasionally infection occurs through a wound of the hand or foot, giving rise to corresponding trouble in the lymph glands of the axilla or groin (the writer has seen extensive tuberculosis of the inguinal glands in an infant resulting from a slight prick of the thigh with a safety-pin). Lymphatic absorption of bacilli from the uninjured intestinal and bronchial surfaces is perhaps not uncommon, thus accounting for obscure cases of tuberculosis of the mesenteric, bronchial, and other glands.

Symptoms and Diagnosis.—Tuberculous adenitis almost always develops slowly and painlessly during the course of weeks, months, or even years, unless mixed infection is present; this chronicity and comparative absence of active symptoms is of much importance in the diagnosis. In rare instances, however, the affected glands may enlarge rapidly, and with more or less pain and rise of temperature. A moderate glandular enlargement is not incompatible with good health in other respects, but if the disease is marked, the general nutrition is apt to suffer. Anemia is often present, with loss of appetite, flesh, and energy. Sometimes the flesh is retained, but the skin has a more or less "pasty" and unhealthy appearance. These several conditions, together with the enlarged glands and a tendency to eczema and catarrhal affections of the mucous membranes, constitute what was formerly designated as the "scrofulous diathesis," but is now regarded as being due to absorption of tuberculous virus. The enlargement of the lymph glands may cease at any time, become latent for a longer or shorter period, or disappear altogether, the course pursued depending largely on the condition of the resisting powers of the patient; but the usual course is a continuous increase in size, accompanied by infection of neighboring glands, frequently terminating in periadenitis and the formation of abscesses and fistulæ. Death seldom results, although it may occur from sepsis, exhaustion, or amyloid changes; but extensive disfigurement is not uncommon, from unsightly scars and swellings, especially about the neck. There is considerable danger of tuberculosis appearing elsewhere —for instance, in the lungs—which is a strong argument in favor of early and energetic treatment.

In forming a diagnosis, the chronicity of the disease, together with the absence of inflammatory symptoms, usually serves to distinguish it from acute adenitis. *Mixed infection* may lead to confusion; but if enlargement of the nodes persists after the acute manifestations have subsided, tuberculosis should be suspected, especially following an infectious disease in childhood. In fact, any chronic glandular enlargement in a child should be looked on as being tuberculous unless it can be demonstrated to be from some other cause.

Differentiation from *Hodgkin's disease* or *malignant lymphoma* is often difficult, and mistakes are frequently made. Tuberculous glands, however, usually develop more slowly without reaching so large a size. They are harder at all times unless abscesses form, and if numerous and of considerable size, when confusion is most likely to result, they are, as a rule, immovable from periadenitis. Sinuses are also apt to exist, together with involvement of the skin. In Hodgkin's disease, on the contrary, the glands enlarge extensively and rapidly, and are soft,

smooth, movable, and easily outlined, without the matting together which is so characteristic of tuberculosis.

Cysts and other *tumors* can usually be recognized by attention to the family and personal history and to local appearances, the use of tuberculin in the diagnosis being seldom required. *Syphilis* is recognized by the history, the acuteness of the glandular enlargement, the presence of other specific lesions, and the absence of sinuses, skin involvement, etc.

Treatment.—This is both general and local, the latter being divided into nonoperative and operative.

General Treatment.—This is always indicated, either for its curative effect in early stages or as a safeguard against relapse following operation.

Hygienic measures are of the utmost importance—good food, plenty of air and sunshine, and appropriate exercise. It has long been observed that patients do remarkably well at seaside resorts, and it is beginning to be recognized that residence in a dry climate, at a high altitude (in Colorado, for instance), is even of greater service.

Medicines accomplish but little, as a rule. Those most in use are the sirup of the iodid of iron, the hypophosphites, creosote, and guaiacol. The vaccine therapy of Wright is still on trial, and it can be said that encouraging results have been obtained. The size and frequency of the doses of tuberculin are determined by noting the opsonic index of the patient. So-called specifics, such as cinnamic acid, although highly recommended by some, have not come into extensive use. In fact, the question of medication seems, at the present time, to consist more in building up the resisting powers of the patient than in attempting to kill the germs of the disease with specific drugs.

Local Treatment.—Massage, and crushing the nodes between the fingers, or their subcutaneous division with a tenotome, are all dangerous and ineffective methods, favoring both local and general dissemination. Passive hyperemia (Bier) may be tried in suitable cases, although in the neck, groin, and axilla the effective application of the constricting band is rather difficult.

Ointments and counter-irritants are of doubtful utility, although extensively employed. Among the former may be mentioned ichthyol, resorcin, and the iodid of lead, and among the latter tincture of iodin and green soap. Troganow places a hot-water bag on the nodes for an hour or two each day, claiming much benefit from its employment. The X-ray is occasionally of service, especially in incipient cases.

Injections into the glands have long been employed. Some substances are used for their direct curative effects, such as tincture of

iodin (5 to 10 drops every four days); Fowler's solution, in increasing doses (8–10–12 drops); solutions of carbolic acid, acetic acid, nitrate of silver, corrosive sublimate, guaiacol, phosphate of iron, etc. Other materials, such as chlorid of zinc (two to ten per cent), stronger solutions of carbolic acid, papain, etc., are used to cause rapid liquefaction of the glands. The method of Calot, for instance, is to inject two-per-cent chlorid of zinc every other day, until purulent softening occurs, when the fluid is aspirated and replaced with camphorated naphthol.

These procedures, although they have been strongly advocated, are often disappointing, and are not free from discomfort and even danger, as evidenced by cases of poisoning from camphorated naphthol. If injections are used, the best is probably ten-per-cent iodoform in olive oil, which must be sterilized carefully. Into nodes which have not yet broken down, about half a hypodermic syringeful is inserted every eight to ten days, while glands containing pus are aspirated and filled with the material.

In estimating the value of the injection treatment it must not be overlooked that, although certain glands may disappear, there are often others which cannot be reached or even recognized without a surgical operation, and which are apt to give rise to trouble in the future.

Operative Treatment.—This is indicated in most cases, the presence of pulmonary tuberculosis being no contraindication to operation unless quite advanced, as improvement often occurs after the removal of the nodes.

Curettement is principally applicable to sinuses, the results being good where it is possible to reach all diseased material in the underlying glands. The infected skin around the opening of the sinus must also be removed. Cauterization with chemicals, such as ninety-five-per-cent carbolic acid, is occasionally of service. Tuberculous sinuses may often be treated successfully by suction, according to *Bier's method.* A small cupping glass, provided with a rubber bulb, is placed over the sinus, and by means of pressure on the bulb the air is exhausted to an extent sufficient to cause marked hyperemia. This empties the sinus and may produce some capillary bleeding, which is beneficial rather than otherwise. The procedure is carried out daily, each sitting lasting about three quarters of an hour, with the cup in place a few minutes and then removed a few minutes during this time. When the discharge becomes watery the intervals between the cuppings are lengthened.

Extirpation of tuberculous lymph glands, when possible, offers a better chance for permanent recovery than any other procedure, but the operation must be thorough or relapses will supervene.

TUBERCULOSIS OF THE CERVICAL LYMPH GLANDS

There are several hundred lymph glands in the neck, some of them superficial and others deep. They exist principally in definite groups, which are usually infected from the tonsils, teeth, and pharynx. Tubercle bacilli may also gain entrance from a chronic otitis, eczema of the scalp, ophthalmia, or various nasal troubles, or they may be deposited from the blood or ascend from the bronchial lymphatics. The nodes most frequently involved are those in the submaxillary region and those lying along the jugular vein. The submental and parotid regions are at times implicated, as well as the regions about the mastoid and above the clavicle.

Often the disease appears on one side only, but occasionally the entire neck is involved, giving rise to great disfigurement. It has been estimated that pulmonary and other infections follow tuberculosis of the cervical lymph glands in more than twenty-five per cent of the cases, a serious danger which should not be underestimated.

Whatever form of treatment is selected, it is of prime importance to abolish, if possible, the original source of infection by attention to teeth, tonsils, pharynx, and nose, and by the eradication of inflammations of the ears and scalp. The importance of this is emphasized by Goodale, who insists that many enlarged lymph glands can be reduced merely by treating the tonsils with solutions of iodin.

The most satisfactory and lasting results are obtained by extirpation of the nodes, unless the vaccine therapy of Wright proves to be of greater service than can at present be predicted. Such operations vary from the easy excision of a single gland to procedures which are among the most difficult in surgery owing to the number of the nodes and their relations to important nerves and vessels; but in spite of this, every diseased gland and tissue should be removed or relapse will promptly appear.

The skin incision should be planned to suit the individual case, following natural folds and concealing scars as much as is consistent with thoroughness and safety; but no greater surgical indiscretion can be committed than to attempt to remove a mass of enlarged, matted, and adherent nodes through too small an opening. Dollinger's incision, for instance, which is located entirely within the hair back of the ear, is generally inadequate from the standpoint of thoroughness and safety. It should always be borne in mind that several transverse scars may be less objectionable than one longitudinal scar, because they are less liable to stretch or become hypertrophied into the red, raised, and unsightly cords which are often seen following cervical operations. Subcutaneous sutures should be used when possible.

Theoretically it is best to remove in one mass all the lymphatic structures, and the connective tissue in which they are embedded, but practically this is not always possible, and the operator must be content with the enucleation of the glands alone, which fortunately is usually sufficient. It is seldom necessary to divide the sternomastoid muscle.

Although injury to the internal jugular vein is not frequent, it is nevertheless wise to expose it early in the operation, if possible, being ready for compression or ligation, if necessary.

Constant vigilance is necessary to avoid injury to various nerves, the most important of which are the spinal accessory, pneumogastric, phrenic, laryngeal, sympathetic, and facial, especially as they may be forced from their normal positions by enlarging glands and inflammatory tissues. Division of the phrenic nerve is a serious accident, but the pneumogastric or sympathetic may be cut without disaster following. The facial and recurrent laryngeal nerves must be avoided with the greatest care, owing to the unfortunate results following their injury. The possibility of penetrating the pleura or of opening the thoracic duct should also be borne in mind.

Anesthetic areas of skin—for instance, about the ear—due to interference with cutaneous nerves, are apt to cause some annoyance, but fortunately they tend to disappear in time. Temporary drainage of the wound, combined with moderate pressure of the dressings, will prevent the accumulation of blood and serum, which might lead to infection.

It is difficult to estimate the number of complete and permanent cures following radical operations. Wohlgemuth claims 70 per cent, Hobel 68 per cent, and Van Noorden 62.4 per cent, an average of 65 per cent in 309 cases, while Blos estimates the number at 46 per cent and Billroth at but 24 per cent. From these figures it is seen that repeated operations are sometimes necessary, owing to the occurrence of relapses. The prognosis is generally admitted to be more favorable in children than in adults.

TUBERCULOUS INFECTION OF THE LYMPH GLANDS OF THE GROIN

This form of tuberculosis is more frequent than is generally recognized, although it is far from common. It is usually mistaken for a complication of some venereal disease, at least until its stubbornness and chronicity arouse a suspicion of tuberculosis. The source of infection may be somewhere on the lower extremity—about the genitalia, around the anus, or within the pelvis—but quite frequently no original focus can be detected. The disease may attack both deep and super-

ficial glands and exhibits a marked tendency to spread upward through the lymphatic structures surrounding the iliac vessels.

As in tuberculosis elsewhere, operative intervention, in order to be of service, must be thorough, which often means a large opening and an extensive and difficult dissection. In order to follow the disease into the pelvis, an incision must be made extending from the spine of the pubes to well beyond the anterior superior spinous process of the ilium, with division of Poupart's ligament near its internal end. The unopened peritoneum can then be retracted upward, exposing the vessels and the glands surrounding them as far as the bifurcation of the aorta, if necessary (Lennander). The patient should be warned that a species of elephantiasis of the lower extremity and genitalia may follow an operation in which all the inguinal lymphatics have been removed, although such an unfortunate complication is uncommon.

TUBERCULOSIS OF LYMPH NODES IN THE AXILLARY REGION

These glands may become enlarged in connection with those of the neck, or the focus of infection may be situated on the fingers—an "anatomic tubercle," for instance—or in the mammary gland.

Extensive and careful operations are necessary, which must be carried out with due reference to the large vessels and nerves of the part. The incision should be sufficiently large, and not pass through the axilla itself, but above the anterior axillary fold, as in carcinoma of the breast, in order to avoid embarrassment of shoulder motion arising from hypertrophy and contraction of the scar.

CHAPTER II

TUBERCULOSIS OF BONES AND JOINTS

By L. L. McARTHUR

TUBERCULOSIS OF BONES

Tuberculosis invading bony structures differs in no wise from tuberculosis in other parts of the body except in so far as the histologic structure of the tissue influences the growth or is influenced thereby. It seems unnecessary to repeat what has already been said elsewhere in this volume of the microscopic pathology, or to enter into a discussion of it, and therefore attention will be directed to practical factors met clinically.

It is now universally accepted that there can be no tuberculosis without the bacillus of Koch. A definite understanding as to the manner in which infection occurs will serve to make clear many otherwise obscure points in this disease. Infection occurs only through the circulation. Many writers speak of primary bone and joint tuberculosis. This must not be understood in the sense of entire absence of other foci in the individual, since postmortem examinations reveal other discoverable foci in seventy-nine per cent of the cases (Koenig). In the remaining cases (twenty-one per cent) no other focus could be found. It has been proved experimentally and clinically that the bacillus can pass through the intestinal mucosa without discoverable lesion, thus gaining access to the mesenteric lymph stream, and then to the general circulation. Clinically, therefore, it is proper to consider a bone or a joint tuberculosis as a single manifestation (often a metastasis) of a multiple infection, and hence attention must be given to the general as well as the local treatment of the disease.

Joint or bone tuberculosis presupposes that the bacilli are floating in the blood stream, or leucocytes containing them. That such is the case has been demonstrated experimentally, clinically, and pathologically. Such floating organisms become arrested in the bones or joint under two different conditions: (1) In the arterioles; (2) in the blunt venous terminals.

In the Arterioles.—Under certain conditions—as, for example, a liquefying lymph gland—a clump of organisms gains access to the circulation, and later lodges in a bone arteriole, wholly or partially plugging it and producing an infarct in the area beyond. This infarct usually is wedge or cone shape, the base of the cone being directed toward the articular surface.

As this is a bacterial embolus, and the newly formed hemorrhagic infarct is an excellent culture medium, the latter becomes tuberculous and constitutes a common type of focus seen in bone. Anatomically this is peculiarly true of the arterial terminal twigs which nourish the articular ends of long bones, thus determining the shape of foci occurring here. Such foci, as a rule, undergo the characteristic degenerations of tuberculous tissue elsewhere. They may become surrounded by granulation tissue, itself tuberculous, thus constituting a tuberculous sequestrum. These sequestra are never so sharply defined as are the sequestra of an acute osteomyelitis, but can occasionally be lifted out *en masse*. Rarely such an infarct may become inclosed by a capsule of ivorylike hardness—the eburnated infarct.

In Venous Terminals.—There is to be seen in the vascular distribution to the epiphyseal cartilage of bone a condition scarcely found in any other part of the body, that of the termination of the blood-vessels in blind *cul-de-sacs*, these pouches resting with their blunt extremities directly against the cartilage. It is easily understood how the sluggishness of the circulation in such a blood-vessel as this might favor the lodgment and growth of such infective elements. Clinically this is just what is observed; the majority of tuberculous bone foci occur in close proximity to, and usually on the joint side of, the epiphyseal cartilage. Only rarely do we find the tuberculous process involving primarily the shaft. When this does occur it forms the so-called tuberculous osteomyelitis (osteitis sicca tuberculosa); it is usually progressive in character, and of serious prognosis.

The infective elements having gained lodgment in the manner described, the characteristic tubercles soon form. Occurring in bony structure, however, they induce, probably by pressure, a calcareous absorption. Just as a varicose vein may, by pressure, groove the tibia, so the tubercular granulations in their growth dilate the cavities in which they lie, until the bony lamellæ which comprise them are partly or wholly absorbed, with a resulting osteoporosis, often demonstrable by the X-ray. The bone is replaced by tuberculous tissue which, when degenerated, seeks an exit. The caseous material escapes in the form of a granular semifluid detritus along the lines of least resistance. If the tubercle is transformed into fibrous or calcareous material, it then may become encapsulated, lying dormant until a trauma excites renewed activ-

ity. It is almost incredible how long the local process may remain quiescent.

It is probable that in every case of bone tuberculosis there exist other etiologic factors than the tubercle bacillus. Trauma is the most important, and it may occur in the form of heat, cold, and also toxins, or even other infective processes. The young articular ends of bones are more easily traumatized than is the shaft; hence the frequency with which tuberculosis localizes there in the young.

Sometimes the granular detritus makes its way into a neighboring joint, or it passes out through the bony lamella to the surface in close proximity to the joint. If, in the latter case, surgical measures are resorted to promptly, the joint may be saved from infection and necessary incision and drainage.

When the contents of the tuberculous abscess escape into the adjacent soft parts, a so-called cold abscess forms. Unlike abscesses produced by acute infective agents, it is extremely slow in formation and slow in perforating the skin (since the tubercle bacillus induces no such cytolytic action as do the acute inflammatory organisms). The contents of the abscess consist of a few leucocytes, many fat granules, fine bone fragments, the so-called "caseous matter," albumin, and other products of degeneration. The cardinal signs of inflammation are also wanting, especially as to local temperature, pain, and redness. Only when the inflammatory process involves the skin follicles is there redness, and even then it is only a dull bluish-red. If mixed infection occurs, as does occasionally happen, then the clinical history rather than the local appearance aids in determining its nature. The skin having been broken, or opened by the surgeon, fistulæ result. The sinuses leading to the tuberculous foci are lined by tuberculous granulation tissue, and their orifices present the dull gray, pale, edematous, often diphtheroid, appearance which is so typical. These sinuses may persist for weeks, months, or years, and when they heal they may cicatrize so strongly as to make the deep craterlike scars so often seen.

Treatment.—The only rational treatment of localized tuberculosis of bone is surgical. Whatever the procedure employed, and it will, of course, vary for different bones, it must be radical to be efficient.

TUBERCULOSIS OF SPECIAL BONES

Cranial Vault.—Until the surgeon has learned to appreciate properly the fact that the disease spreads in the vascular layer of the diploë far beyond any external evidences, his operative intervention will be futile. It is absolutely essential to remove the external plate until all of the granulating layer has been uncovered, and the normal vascular

area is exposed on all sides. Healthy areas are easily recognized. The disease usually presents itself as a painless, fluctuating, nonfebrile mass beneath the scalp, which on opening presents the characteristic of a "cold abscess"—a cheesy, flocculent pus.

Ribs.—Here, as in the cranial vault, the disease is of the rapidly infiltrating type, with the point of inception most frequently at the cartilaginous junction. Until the periosteum has perforated and the cold abscess begun to form, it may escape detection by the surgeon, or be unsuspected by the patient. Clinical experience has shown that the old "caries costarum" need no longer be a "bête noire" to the surgeon. It is known that the disease spreads beyond the apparent localization, and partial operations, curettings, etc., for the radical removal of the greater part of the rib have been abundant. Spontaneous fracture occasionally results.

Fig. 177.—Case of Pott's Disease. (Sea Breeze, Coney Island.)

Sternum.—Tuberculosis of the sternum, though five times less frequent than tuberculosis of the rib, presents similar conditions. It is somewhat singular that these bones escape early infection, persons of middle age being the ones chiefly affected. The thickening of the sternal periosteum, and the collection beneath it of tuberculous detritus, presents at first a tumefaction (cold abscess), usually without redness, that later terminates in a fistula. Through these fistulæ softened bone is usually to be felt. Perforation of the sternum frequently occurs, with the production of a mediastinal abscess.

Vertebræ.—Because of the frightful deformities, as well as spinal-cord involvements, which tuberculosis of the vertebræ may produce, early recognition of its presence, with the mechanical and surgical treat-

ment which that implies, was insisted on by Pott (1779). When the pressure absorption of the unusually light spongy cancellous tissue by a tuberculous osteitis takes place, the result is a flattening, and the well-known deformity. This is peculiarly the tuberculosis of early youth (second to fifth years), probably because of the greater liability to trauma here than in other bony areas. Motion, too, being persistent, varied, and continuous, proves a constant irritating factor of serious moment. Occasionally a necrosing tuberculous osteitis results in rapid death of the bone without the formation of excessive granulation tissue, due probably to embolic arterial infarcts. Here, as elsewhere, is observed the cold abscess, which, influenced both by gravity and the fasciæ, results in the best-known of all cold abscesses, the psoas abscess.

TUBERCULOSIS OF JOINTS

We may now pass to the consideration of this disease as it affects the articular ends of long bones, tuberculosis of the smaller bones, except the vertebræ, being of less clinical importance. Knowing the anatomic peculiarities of the epiphyseal circulation, it is easy to understand why the infection so frequently attacks the articular side of the epiphyseal cartilage, where the blood current is slower and the vessels terminate in blunt extremities. Likewise clear is the sequence of joint involvement, since escape of tuberculous detritus takes place more easily into the joint than through the denser outer layer of the shaft. We find, therefore, a large proportion of joint invasions occurring in this manner. Joint tuberculosis always affects either (1) the neighboring bone or (2) the synovial membrane. The cartilages, the ligaments, the capsule are never the primary site of infection.

Symptoms.—When the joint becomes thus invaded from the bony side there can be no characteristic prodromal history, since the determining factors of size, location, rapidity of growth of the infective focus, as well as the gradual or sudden emptying into the joint of the infective material vary so widely. Hence, in these cases the first definite manifestation may be impairment of motion or swelling of the joint. Tubercular foci in bone are slow to produce clinical symptoms, the invasion of the more sensitive joint structures or the periosteum often being the first thing to attract the attention of the patient. When this occurs there may be a fixation of the part, due to muscular spasm. Contractures which in certain joints limit motion in certain directions are very significant. If these contractures persist or the disease progresses, certain characteristic postures or deformities result that are considered pathognomonic. Too frequently pain is so slight as to be ignored by the patient, or it is ascribed by the physician or patient

to rheumatism, "growing pains," etc., when if all available diagnostic means were utilized, such as the X-ray, inoculation tests, the opsonic index, v. Pirquet's test, Calmette's reaction, or the search for other foci, many a joint might be spared invasion and there would be fewer cripples.

That heredity exerts some influence is probable, though congenital tuberculosis is extremely rare. The physical condition of the patient does not necessarily bear any relationship to the tuberculous joint; the patient may be in perfect health otherwise. This may be true even when there is a collection of pus in the joint, or when the patient has an incipient pulmonary tuberculosis.

Prognosis.—It must ever be borne in mind that a real or symptomatic cure may take place, and that the tubercular foci may become encapsulated and dormant. Some authorities claim that in such cases there will be a recurrence within fifteen years; others, before the age of forty-five. Direct danger to life is present in the purulent forms, and through septic infection of tuberculous abscesses, which may lead to acute fatal septicemia or pyemia, or to such chronic sepsis as may ultimately cause the death of the patient through degenerative changes in the viscera. As a general rule, death results in forty-six per cent of suppurative joints, in twenty-five per cent of the nonsuppurative, usually from some acute invasion of the lungs, kidneys, intestines, by the same process. Those joint invasions developing from bone foci never heal spontaneously, and rarely by nonoperative treatment. In twenty-five per cent (55 out of 200) of the cases appropriate for conservative treatment, a movable joint is secured thereby.

The **characteristic of a tuberculous joint** is the tuberculosis of its synovial membrane. This may be primary in the sense that the tubercle bacilli were brought to the joint by the circulation (about eleven per cent), but it is often secondary to an infection extending from a bony focus in close proximity to the joint structures. No matter how the infection occurs, the synovial membrane presents the same changes. As in other serous membranes, the first effect of the tuberculosis is to produce an exudate, in this case of a sero-fibrinous nature. Koenig considers the fibrin the most important constituent, since this coagulates and makes deposits on the various surfaces of the joint. These fibrinous deposits usually become organized, capillaries extend into them from below; miliary granulations appear; free particles likewise become fused, fibrous, and ultimately constitute the ricelike bodies or sago grains of a tuberculous joint. The newly formed tissue, granulating in character, may rise from the surfaces of the joint like a papilloma.

Whether the watery constituent of the exudate remains to produce a hydrops, or whether it is absorbed, leaving behind the newly organized tissue, is of small importance. It is only in the very early stage

that the freshly deposited fibrinous material is seen, and it is then that local medication may be effective. In the later stages, when the vascular proliferation from the synovial membrane has become marked, ulceration of the cartilage and exposure of the bone beneath may take place. The cartilage, therefore, plays only a passive part.

When the joint infection has had its origin in a bony focus, or in a large cheesy focus in the synovial membrane, a purulent joint may result—that is, in the sense of a "cold abscess." "Why the pus occurs we do not know. The bacilli are not the cause, since they are rarely to be found. Since other bacteria are not the cause, we are of the opinion that the formation of toxins by the tubercle bacillus causes the caseous suppuration" (Koenig). Motion may be said to favor its formation and development. The pus, although containing few leucocytes and fewer bacilli, is still very infectious (spores?).

In 1894 Koenig wrote: "It would be undoubtedly a great advantage if one could early recognize the osteotubercular cases and those in which a spontaneous healing could not be awaited, for then an early operation, with the patient in good condition, offers the ideal results."

In 1899 the writer called attention to the extreme value of the X-ray as a diagnostic aid in supplying this desideratum, for with it it is often possible to determine the size, location, and type of bony infiltration. The wedge-shaped focus is not always shown by this means. That there does exist, in about a third of the cases, more than one bony focus can often thus be demonstrated, and it is of great surgical import.

A clear understanding of the general characteristics of a joint tuberculosis, in the three forms in which it manifests itself, will render easy the application of that knowledge to tuberculosis of special joints, in which the clinical course will vary as the function, the structure or location prove determining factors. These three varieties, to use Koenig's classification, are:

1. *Hydrops:* Hydrops serosus, hydrops fibrinosus.
2. *Tumor albus:* Fungous, granulating joint, "white swelling" (a late form of hydrops).
3. *Tuberculous suppurative arthritis.*

When the primary synovial tuberculosis has advanced beyond the fibrinous stage to the organized granulating stage, with or without the *hydrops* remaining, there results the second variety, or *tumor albus* ("white swelling"). We here find more or less destructive ulceration of cartilage, perforations of or loosening of it from the bone beneath by a tuberculous osteitis. The joint becomes lined with granulations, sometimes so pedunculated as to give to this stage the name fungus, or villous. Recovery is still possible, but always with imperfect mobility. If, as sometimes occurs, the fluids are absorbed, the condition is termed

a dry arthritis, or arthritis tuberculosa sicca. In either case the joint takes on a spindle shape because of muscular atrophy, thickening of the periarticular tissues, and atrophy of the shaft. *Tumor albus* is not confined to the knee, with which it is usually associated, but it may affect any joint.

Following either the hydrops stage or the tumor albus, and more rarely developing spontaneously, as if from an acute miliary infection, is the third variety of this joint affection—the purulent tuberculous arthritis. In this variety the joint is filled with a purulent fluid; its synovial membrane is covered with a tuberculous exudate, in which miliary bodies are to be found. The purulent variety, whether originating from a bony deposit breaking into the joint or primarily from the synovial membrane, has a mortality, as compared with the non-purulent forms, of nearly two to one, no matter whether treated conservatively or by operation.

Diagnosis.—As in tuberculous processes elsewhere, there is an evening rise of temperature to aid in the diagnosis. While, usually, a joint invasion is single, it may become multiple. When this occurs, the varying degrees of advancement of the process will likewise assist in determining the nature of the lesion. These multiple manifestations go to prove that miliary tuberculosis is not always fatal. This agrees with the experience of the writer, who has observed the acute miliary tuberculosis provoked by a resection of the hip-joint terminate in recovery, even when the case presented the classical symptoms of tuberculous meningitis. If we do not consider the question of function, it can be stated that the large majority of joint invasions heal symptomatically.

It is agreed that pain is not characteristic, many of the joints being surprisingly free from pain, considering the objective involvement. Soreness on pressure at the articular margins, associated with a pronounced synovial thickening; the peculiar, grating "feel" of the slipping of rice bodies or synovial fringes between its layers, aid in the diagnosis, but are not absolutely pathognomonic. The only absolutely positive evidence in the early stages will be by the demonstration of the bacillus in the fluids withdrawn. Positive results obtained by the inoculation of animals are also valuable. This may be tested during the period of conservative treatment or during the preparation of the joint prior to operation. Among the newer aids to diagnosis, two are of special importance, and promise much for the future. They are (1) v. Pirquet's phenomenon and (2) Wright's determination of the opsonic index.

Koch's demonstration that tuberculous individuals react to tuberculin in a specific manner has largely been abandoned because of untoward, even dangerous, sequelæ. V. Pirquet, however, has recently shown that the routine abrasion made preliminary to vaccina-

tion against smallpox, if moistened with tuberculin (Koch), will, in a tuberculous individual, produce a characteristic local reaction. To determine the normal reaction to such a scraping away of the epithelium, two areas, an inch or more apart, are scraped lightly. Only one of these is moistened with tuberculin; the other serves as a control. If the individual is nontuberculous, the two abrasions react alike; if he is tuberculous, a reddened area, becoming more or less crusted, appears. The reaction occurs during the first twenty-four hours. Sufficient experimentation along these lines has already been done to demonstrate that the method, while not infallible, is very suggestive, particularly when applied to children under six years of age.

Wright demonstrated that the phagocytic activity of a tuberculous person's leucocytes to tubercle bacilli varies from the normal, and that this variation is caused by the opsonins. Their presence in the serum prepares the bacillus for ingestion by the leucocyte. Their absence leaves the bacillus uningested. Hence, varying amounts of opsonins cause varying degrees of phagocytosis. By comparing the serum of the individual suspected of being tuberculous with the mixed sera of several individuals known to be free from tuberculosis, there is obtained an index to the diagnosis and to the treatment. This Wright has named the opsonic index. Drs. Lincoln and Vail have proved that there is a normal tuberculo-opsonic index, and that the diagnostic value of variations from the normal is extremely great (eighty-five per cent), when several careful examinations have been made, thus corroborating Wright's, Douglas's, and Bullock's claims.

The writer is convinced that persistent fluctuations from the normal index are diagnostic of tuberculosis. (The details of this subject are more elaborately treated elsewhere.) Hence, in a given joint, if there is an active tuberculous process there will be found departures from the normal index, usually lowered, sometimes raised, occasionally fluctuating. Indeed, the fluctuation is very significant when, having determined the patient's index beforehand, the suspected joint is massaged; for by so doing the exciting factors of opsonin production may be driven into the circulation, thus changing the index, usually raising it markedly.

Treatment.—In a majority of the cases the X-ray serves as an aid in deciding whether there is much hope of recovery from conservative orthopedic measures. In this condition, more than in others, is it necessary to consider every factor to individualize. Surgical intervention is indicated—

(1) When the constitutional condition of the patient shows a progressive deterioration under treatment. This may mean (*a*) sepsis, from absorption of the products of a mixed infection in the joint or

sinuses; (*b*) amyloid degeneration of the viscera; (*c*) pulmonary invasion; (*d*) diarrhea.

(2) The age of the patient should influence the decision, reluctance to operate in very early youth and after thirty growing progressively greater; in youth, because the danger of disturbance of future developmental centers becomes greater, therefore the end results are worse; in later years, because clinical experience has shown that adults bear joint resections poorly.

(3) The environment of the patient should be a factor in determining earlier operation. However illogical it may at first thought appear to make one rule for the rich and another for the poor, it still is practical and necessary to consider the fact that the child of a day laborer cannot undergo the long, expensive trial of orthopedic and climatic measures, occasionally justifiable in the child of the rich, only to submit to resection, with its attendant expense and delay, in the end.

(4) Since, as before stated, it is often possible, by means of the X-ray, to locate the disease and to determine the exact part and proportion of joint affected, it is conceivable how, with a location favorable for removal, an unusually early operation might be justified. Conversely, how in the absence of evident bone disease the case should be treated as one of primary synovial tuberculosis. The writer has always protested against the routine treatment of any joint, first by mechanisms, then by mechanisms plus injections, and finally by operation. Surgeons have too frequently been satisfied with a diagnosis of tuberculosis of a joint (without regard to whether it be (1) osteotuberculosis of one or both bones, (2) primary synovial tuberculosis, or (3) tuberculosis near the joint, but not in it), and then proceeded contentedly to the application of mechanical devices for the rest and protection of the joint, with or without iodoform injections, and without regard to the exact location of the infective center.

Those cases that are cured by Mosetig's glycerin-iodoform and its analogues are cases in which the disease was primarily synovial in origin, and remained so. This is the only form in which there may be a *restitutio ad integrum*, and the time necessary thereto, even in simple cases, is often one to two years! It is reasonable to assume, and the assumption is borne out by clinical experience, that the beneficial action of iodoform is essentially by contact. Hence, it is not reasonable to expect that a focus buried in the articular end of a bone, whose products have broken through some minute opening into the joint, will be influenced essentially by iodoform thrown into that joint! Hence the necessity for refinement in diagnosis and the determination whether it is an osteotuberculosis or a synovial infection. Since anatomic and pathologic findings and clinical experimental evidence teach that only a

small proportion of cases are of primary synovial origin, it follows as a corollary that only a small proportion will be cured by iodoform treatment. Time has shown that it was essentially in those cases in which the iodoform came in contact with the diseased surfaces—i. e., synovial tuberculosis—that healing occurred. In these large tuberculous abscesses of joints the contents should be removed prior to the iodoform injections, though this may even require at times small incisions, the material being too flocculent to flow through needles. Hence, it is well to limit injections to those joints where the clinical history and the X-ray examination showed the case to be one of synovial tuberculosis.

Of course, the intelligent physician will in no case neglect any of the other factors, general or local, which tend to improve the patient's condition; hence, immobilization of the joint, in so far as is indicated; the use of Bier's hyperemia; alternately flooding the diseased area with opsonins; minute doses of tuberculin T.R. ($\frac{1}{1000}$ mgm.) to stimulate the production of opsonins; the actinic rays of the sun (in larger measure found in X-rays) to increase metabolic changes in the embryonal tissues present, will all favor healing. The extremely beneficial action of direct exposure to the sun's rays cannot be emphasized too strongly.

Healing usually takes place by fibrous cicatrization. When, however, the healing is complicated by a cold abscess, often noted under the Bier treatment, proper surgical care of the same should be instituted early—i. e., evacuation under aseptic precautions.

It should be recalled that Bier excepts hydrops as not being amenable to his treatment, and urges not too prolonged fixation. In the case of the knee- and ankle-joints he urges operative treatment earlier than in other joints, because the principal goal—a functionating joint—is here least often obtained by passive hyperemia. Otherwise his results have been so good that army service was almost enforced on some of his patients.

When the tuberculosis is in such close proximity to the joint as to simulate joint disease, even when sinuses exist, such a joint may be spared resection if the surgeon traces the sinus to its source before incising the joint. In this way the writer has saved four hip-joints presenting almost all the classical joint symptoms (see special joints) due to foci situated in the ilium close to the acetabular margin, but external to the joint. Broca, too, emphasized this fact. "When the diagnosis can be made of isolated capsule disease (tuberculous fibroma) it should be treated like a new growth—removed" (Koenig).

When surgical intervention is indicated (and it is in nearly fifty per cent of cases) for a tuberculous joint, what shall be the procedure?

Either

(1) Extirpation of the synovial membrane (arthrectomy),
(2) Excision of the joint (resection), or
(3) Amputation.

Arthrectomy has been tried with success in those cases of synovial tuberculosis which have resisted the usual conservative treatments, and consists in the thorough removal of all diseased synovial tissue. Care must be taken to obtain the most desirable position for the ankylosis which usually occurs. In every useless position correction should at the same time be made. When the disease has been of osteal origin, one can sometimes make a partial arthrectomy if the focus be small, or, if extensive, it may require the resection of the articular ends, preserving, if possible, the epiphyseal cartilage, since on this future growth depends. In the lower extremities the epiphysis nearest the knee, and in the upper extremities the epiphysis farthest from the elbow, exert the greater influence on future bone growth.

In adults with suppurative joints arthrectomy gives a lower mortality than resection, probably because the vessels of bone are not opened. When the structures in and about the joint are too extensively involved, or when the mixed infection is producing a dangerous toxemia, or when there is amyloid degeneration of other organs, it may even be necessary to amputate the member to save the patient's life. In these healed joints with ankylosis, at some later period, Murphy has demonstrated how excellent functional results may be obtained by the interposition of the subcutaneous cellular tissue between the articular ends.

TUBERCULOSIS OF SHOULDER-JOINT

Occurrence.—Although tuberculosis of the shoulder-joint is relatively rare (knee six times as frequent), either variety of invasion may be met with, ranging in frequency, respectively, (1) bony focus in humeral head, (2) primary synovial tuberculosis, (3) bony focus in glenoid process of scapula.

Symptomatology.—Aside from some vague sense of pain and discomfort about the shoulder, there may be, in the early stage of the first and prevailing form, practically no other symptom. An X-ray picture may reveal the location and extent of the focus, the nature of which could then be confirmed by the methods mentioned in the preceding pages. If the lesion has invaded the joint, thus infecting the articulation, or if the disease primarily invaded the synovial membrane, there then follow effusion, swelling of joint, limitation of motion, and severe pain. Rice bodies are found next in frequency to knee. An early involvement or destruction of the biceps tendon, with the resulting cold

abscess course, is determined by the same. When the capsular perforation is near the insertion of the other tendons, sinuses develop and follow the course of these tendons.

Differential Diagnosis.—The slow onset, the absence of marked febrile disturbances and redness, aid in differentiating the condition from simple *rheumatism*; absence of gonorrheal history or discharge, with normal gonococcal index, differentiate it from *gonorrheal arthritis*, while the low tuberculo-opsonic index, the character of the aspirated fluids, their infectivity to the joints or peritoneum of the animals, together with the family history, the slight evening rise of temperature, will make reasonably clear the character of the infection.

Prognosis.—Clinicians agree that the mortality of shoulder-joint infections exceeds that of other joints, though in an indirect manner—i. e., by pulmonary (forty per cent) or other fatal internal invasion. Koenig considers the prognosis for healing very unfavorable. Rarely do the fistulæ close up. Conservative treatment fails to help the caries sicca, and the best prognosis is found in those cases in which the disease can be removed by operation. Operation is attended by twenty-five per cent mortality, directly or indirectly; seventy-five per cent of patients have more or less useful joints, limitation of abduction, elevation, and rotation being the chief deficiencies.

Treatment.—If the diagnosis is made prior to the invasion of the joint, too much time should not be wasted in conservative treatment, fixation, etc., but early surgical intervention is necessary. When there is evidence of slight bone involvement, and yet joint effusion, enlargement, capsule thickening (often detectable at the bicipital groove, where it occasionally is localized), and other factors going to make up the symptom-complex of tumor albus are present, iodoform-glycerin injections may prove efficacious. The writer has seen such joints restored to apparent perfect function thereby, even with progressing pulmonary invasion and double psoas abscess in the same individual.

The possibility of occasional tuberculosis of the subdeltoid bursa, without joint involvement, must be borne in mind.

When abscesses and fistulæ exist, nothing remains but surgical intervention, which should seldom be limited to opening of the abscesses, curetting the fistulæ; a resection should be done. Experience teaches that milder procedures yield poorer results here than elsewhere. The shoulder and the hip do not permit of employing Bier's treatment.

TUBERCULOSIS OF CARPUS AND TARSUS

Invasion of these areas with the infective elements occurs in a manner similar to that described in the case of the larger bones and joints.

Occasionally a single bone or joint is involved, and the surgeon may, by early interference, save the remaining unaffected joints. (The scaphoid is exempt from primary disease.) Here, however, because of the very small size as well as the intimate relationship of one with another, and the frequent existence of but one synovial membrane for several articular facets, it is rarely possible to decide whether the invasion has been primarily osteal or synovial. In either event, both early become merged.

The treatment does not differ from that employed elsewhere, but inasmuch as there is usually both bone and synovial involvement, the injection treatment is rarely employed. Protection from trauma, immobilization, exposure to direct sunlight (after the removal of the bony foci of the process has gone on to the formation of a cold abscess or fistula), will give the patient the best chance, ultimately checking the process and leaving a useful, if impaired, part.

TUBERCULOSIS OF HIP-JOINT

True cases of primary synovial tuberculosis of the hip-joint are rare, and seldom are adapted to the iodoform-injection treatment. When it does occur, however, the effusion is less, the pathologic changes are less marked, the granulations about the cartilaginous margins are less extensive, the amount of fibrin is less, and fewer rice bodies are ob-

Fig. 178.—Characteristic Position of Tuberculous Hip-Joint. Multiple fistulæ.

served than in the knee-joint or other joints. The caseous products from the primary synovial form (or from that of osteal origin) tend to accumulate about the neck of the femur, close to the trochanters, thus producing a tumor mass whose volume is increased by the thickening of the synovial membrane, and it can usually be palpated prior to perforation of the capsule.

From the fact that tuberculosis of this joint is observed twice as frequently in the male as in the female, the inference is drawn that trauma is a strong exciting factor. Likewise, its occurrence before

the age of fifteen, in eighty per cent of all cases, emphasizes that it manifests a predilection for the early period of life. In fifteen per cent of the cases trauma is the exciting cause, but infective fevers such as scarlet fever (three per cent) occasionally supply that factor.

Hip-joint tuberculosis does not pursue a definite course. It may alternately improve or relapse, whether treated by the best-recognized conservative methods or left untreated. Since the synovial type of the disease is so rare, it is not strange that Riedel found seventy per cent of operative cases with sequestra—i. e., bony foci.

Because of the superficial resemblance of the normal ossific centers, while being transformed into bone, to tubercular sequestra, care must be taken not to remove these and not to disturb the epiphyseal cartilage. This is especially to be remembered in patients between the ages of two and ten years.

Elsewhere reference has been made to the occasional simulation of chronic hip trouble by foci outside the hip. Hence, the preliminary step in every fistulous hip should be to determine the exact point to which the tract leads before proceeding to make the classical incisions for partial or total joint resection.

Sequestra.—A large proportion of all cases operated on (seventy per cent—Riedel) are found to contain bony foci in the form of softened tubercular sequestra, requiring removal to effect a cure. The resemblance, on superficial examination, in the early years of life of the normal centers of ossification to these tubercular foci has occasionally led to their removal, with a loss of future growth. Only when they are distinctly tuberculous should they be removed.

As mentioned elsewhere, the bony focus is occasionally outside of this joint, either in the ilium, trochanter, or neck of the femur, but in such close proximity to the joint as to produce most of the usual hip-joint symptoms. If the surgeon fails to determine prior to his radical intervention the points to which the sinuses lead, he may find himself in the unpleasant predicament of opening a joint as yet uninvaded. In the absence of a distinctly demonstrable "bony crepitus," the sinus or sinuses should be traced to their proper origin. By observing this practice, two to three per cent of the hip-joints will escape unnecessary opening.

When such foci break into the joint, and the condition is recognized early, the prognosis of operation is favorable. The X-ray here renders good service by showing the clear-cut, smooth, articular surfaces, as yet unmarred by the destructive changes so common in the later stages. If the X-ray shows an extensive osteal focus, it would be futile to employ palliative measures.

Symptoms.—*Pain*, with partial or complete fixation of the joint, may be said to be the first as well as the most important symptom to attract attention. This pain is a soreness provoked by motion or weight rather than a sensation independent of such conditions. (Nocturnal pains occur through movements while the musculature is dormant.) The occurrence of contractures in certain muscles or groups of muscles is to be awaited, but these are no longer regarded as so typical or significant as was formerly taught. Their existence for any protracted period results in atrophy; hence the flattening of the gluteals and obliteration of the gluteal fold.

The pain may be referred by the patient either to the hip- or knee-joint. In the latter case it is due to a reflex passing along the nerve trunk supplying sensation both to the hip-joint as well as to the anterior aspect of the thigh and knee. This may be the only pain complained of by the patient. Provoked by the friction of the affected surfaces, involuntary muscular contractures occur which serve to minimize it. Unlike all other joints, however, the ball-and-socket type has all its articular surfaces in constant contact; hence variation of position cannot wholly relieve the affected area from pressure. At the same time the muscular spasm increases the undesired pressure and friction, which here, as elsewhere, ends in pressure atrophy, with absorption either of the femoral head, if that be the chief site of invasion, or of the acetabular margins, or both, unless prevented by appropriate surgical intervention.

As a corollary to the above, absorption of the bony head and neck, or acetabular margins, and shortening (fifty per cent of cases) ensues, made evident by actual measurement and subjective findings. As the acetabulum becomes more shallow, partial or complete luxation of the femoral head may result with a change from the early outward to the late inward rotation. Rotation, then, is an early sign of hip-joint involvement. For a long time Bonnet's experiments have been accepted as explaining this rotation, since they showed that the position assumed was that in which the largest amount of effusion in the joint could be accommodated with least tension—i. e., abduction, slight flexion, and outward rotation—to be followed, in the later stage, by abduction, marked flexion, and inward rotation. The latter is the more serious because it is indicative of more extensive disease. Occasionally this stage is observed in the beginning without the preceding external rotation. It is indicative of an extensive, painful bony focus.

When the disease has its origin in the acetabulum, it occasionally happens that the Y cartilage, with its accompanying wormian bone, succumbs to the destruction, followed by perforation and pelvic (cold) abscess.

Next to pain, in symptomatic importance, is the *limp*, which, seen a few times, assumes considerable significance when associated with the other factors. Swelling can usually be determined by palpation over the anterior aspect of the femoral neck quite early in the joint involvement.

Fig. 179.—Multiple Fistula Openings of Tuberculous Knee.

Although all these symptoms —pain, painful spots, swelling on the anterior surface of joint, and limitation of motion, either active or passive—may disappear after rest in bed; they point to some definite pathology.

Diagnosis.—So much has been written on this phase of the subject that passing reference only will be made to the nontuberculous (ten per cent) hip-joints, of which the acute infection coxitides in the young adult offer such difficulties in differentiation. They are usually caused by the Staphylococcus albus or aureus. In the history the point of systematic invasion must be sought after. The high temperature, the acute onset, the sudden, severe pain, and the absence of ossific change shown by the Röntgen ray will usually settle the diagnosis. On several occasions the writer has been able, by aspirating the hip-joint with a long needle parallel to the femoral neck, to secure synovial fluid containing the staphylococcus, the *Bacillus typhosus*, or the streptococcus. A history of scarlet fever, measles, or gonorrhea has aided in the differentiation.

It must not be forgotten that almost the entire symptomatology of a tuberculous hip-joint may be simulated in hysteria.

Treatment.—Treatment of this form differs only from that of other tubercular joints, because (1) of the weight it supports, hence rest and extension; (2) securing the greatest function by selecting the most

useful position, if limitation of motion occurs; (3) forbidding use of the limb until all tenderness has disappeared, even that produced by blows on the knee, over the trochanters, or by direct pressure over the acetabular rim.

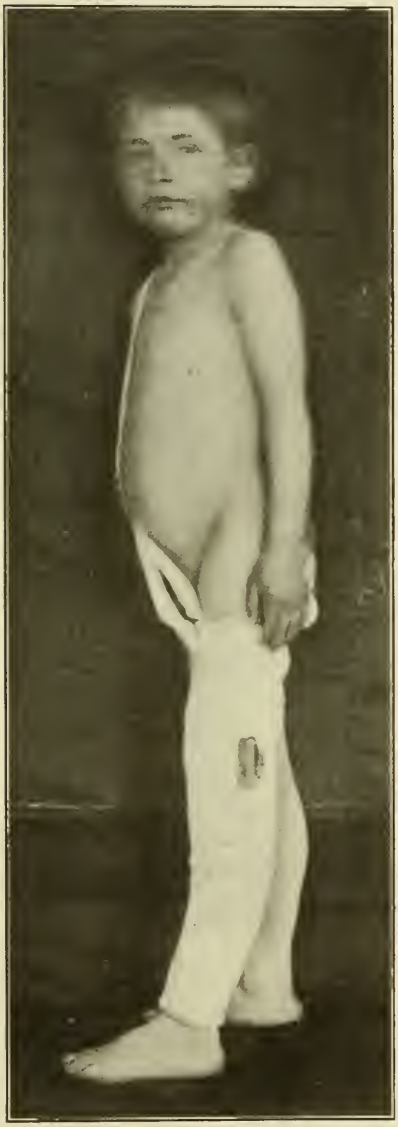


Fig. 180. — Plaster-of-Paris Splint with Fenestra.

TUBERCULOSIS OF KNEE-JOINT

The general description of joint tuberculosis was written with the knee-joint in mind, hence only data of special interest need be mentioned. It is more frequent in males (ten per cent), is seen in the first two decades of life (fifty-five per cent), with trauma an exciting factor (twenty per cent). The knee is peculiarly adapted to the formation of polypoid growths, hence they and the rice bodies are most often seen here. The latter also attain an unusual size. Both of these are more easily felt in this joint than elsewhere, especially over the condyloid margins, with the joint held at right angles.

Atrophic changes occurring in muscles relatively so much larger make more pronounced the spindle-shape of a tuberculous knee of prolonged duration. This somewhat characteristic shape is not always indicative of tuberculosis, however.

In the early stage (hydrops) motion is usually excellent; during the fungus stage it is the reverse, even passive motion being restricted. There is slight flexion, with outward foot rotation, with final backward tibial luxation. In so large a joint, supporting so much weight, we may logically expect an ultimate mixed infection

because of the constant irritation of the inflamed surfaces, determining the lodgment of organisms floating in the blood stream. Indeed, fifty per cent of all such cases become thus complicated, rendering the prognosis more grave. Of 720 patients observed for eighteen years by Koenig, 430 recovered, with useful limbs, but only 11.7 per cent were functionally perfect.

CHAPTER III

PRIMARY TUBERCULOSIS OF MUSCLES AND FASCIÆ

By LEONARD FREEMAN

This is a rare affection, but few cases having been reported, although secondary involvement from an adjacent focus—for instance, in the glands or fascia—is common enough. Primary infection takes place through the blood, and usually results in the formation of a cold abscess. This may be opened, curetted, and drained; but it is, perhaps, better to extirpate the diseased tissue completely, if this can be done without sacrificing the muscle to too great an extent.

Tuberculosis of fasciæ is frequently associated with tuberculosis of lymph glands, bones, and joints, although primary infection rarely occurs. The disease is difficult to eradicate except by a thorough operation, which may necessitate the extensive removal of the affected fascia from between the muscles or from beneath the skin. Treatment by Bier's passive hyperemia may be tried in suitable cases, as may also vaccination with tuberculin, according to Wright.

CHAPTER IV

TUBERCULOSIS OF THE BRAIN AND ITS MEMBRANES

By L. L. McARTHUR

THE MENINGES

Until within a very few years, meningeal tuberculosis was considered as an incurable affection wholly within the province of the internist. That there begins to be doubt as to the accuracy of this view is partly due to the revelations which surgery has made in the cure of similarly affected serous membranes elsewhere, partly to the few but authentic cures which surgical intervention has brought about.

Here, as elsewhere, invasion is almost invariably through the circulation, since the bony vault protects so well against direct infection that extension to the membranes by contiguity is the rare exception. This being true, there follows, as a corollary, the existence elsewhere in the body of a tuberculous process. It is a clinical fact that over four fifths (eighty-three per cent) of all cases occur during the first five years of life.

Until recently the surgeon, for practical purposes, classified meningitis into two general classes: (1) the tuberculous and (2) the nontuberculous. The diagnosis made, he has been too content to rest; but aggressive interference in cases heretofore regarded as hopeless has given some encouragement for the future (Duret). Though the anatomic differences between tuberculous and the nontuberculous meningitis are quite definite, the clinical differences are not always sufficiently definite for easy diagnosis.

Diagnosis.—With the recent advancements in laboratory methods, the nontuberculous cases can be separated from the tuberculous.

Symptoms.—The symptomatology of meningitis being wholly dependent on the irritation of the inclosed nerve tissue, there is no single pathognomonic symptom. Quincke's lumbar puncture has enabled us to disregard many symptoms common to all meningitides, as well as to detect those running an almost symptomless course (Zappert says sixty-six per cent). A normal cerebrospinal fluid should contain no cellular elements. In tuberculous meningitis lymphocytes are prevalent,

more especially in the later stages; in the very early the polynuclears prevail. This is the end result of many observations, and thus limits the value of the cytodiagnosis taken alone.

In the majority of cases (seventy per cent) the tubercle bacillus can be found in the fluid. Failure to find the organism with the microscope may require inoculation to be positive. The agglutination tests of Arloing are not constant, but when positive are valuable as confirmatory evidence. Moreover, the extent of the lesion bears no regular relation to the severity of the symptoms.

Three cardinal symptoms attend a meningitis: *Headache, vomiting,* and *constipation.*

Continuous and distressing headache, accompanied by vomiting without indiscretion in diet, explosive in character, with little or no nausea, and associated with an obstinate constipation, is the usual status found.

Ballance adds to this two groups, those presenting (*a*) symptoms of fever and impaired nutrition; (*b*) symptoms which are the clinical expression of the irritation of the subjacent cortex. These are: (1) Psychic; (2) motor; (3) sensory; (4) vasomotor, and (5) those due to destructive action on nerve cells. Under these headings would come irritability, disturbance of sleep, *cri cérébral,* headache, vomiting, Kernig's sign, ocular or facial paresis, rise of temperature, slowed pulse, stiff neck, etc.

In most cases of tuberculous meningitis the onset is insidious, rarely fulminating. In location, chiefly involving the basal membranes, it may extend to the vertex, or be localized to a given area, producing positive localizing symptoms. Its duration, varying from seven to fourteen days on the average, may extend to several weeks.

The exudate is of grayish-yellow color, with scattered nodules, the basal nerves being ensheathed therein. The membranes of the Sylvian fissure are similarly infiltrated, the cerebrospinal fluid is increased in quantity, the ventricles dilated, and their spendyma showing miliary bodies. Thickening of the latter may be sufficient to occlude their exit. It is rarely found in the form of a tuberculous abscess. Such infectious diseases as whooping cough, measles, etc., prove favoring factors.

Treatment.—So extremely fatal has this disease been regarded in the past, that the diagnosis made, interest and activities on the part of the medical men ceased. Realizing that the dangers of the disease have in no wise diminished, the surgeon has come to understand that here, as in the similarly desperate conditions—e. g., of general peritonitis—a certain small percentage of cases can be saved by heroic measures. In less severe cases, less radical procedures offer some hope where heretofore there was none.

Ballance has called attention to the fact that too frequently in the

past the surgical efforts to check a meningitis have ceased with drainage of the dura, though the tuberculous disease involves the pia and the subarachnoid spaces. Such surgery he compares to drainage of the pleura for pericardial effusion. Hence, the Sylvian lake, the ventricles, the basal areas, or the spine, should be drained when proper indications exist. While the conditions differ (because of many added factors of danger) from those of tuberculous peritonitis, still something may be hoped for from proper surgical interference.

While not an advocate of operative interference in every tuberculous meningitis, nor of drainage through and through with lavage of the cavities bathed by the cerebrospinal fluid, the writer is convinced that the withdrawal of the excessive quantity (10 to 30 c.c.) either by spinal puncture, trephine openings, or ventricular tappings may, by the reduction of cranial pressure and by the escape of infective elements, prove the turning point in an otherwise fatal case. Indeed, cases begin to accumulate that have been saved by such methods. Surgery as applied to any given case should at least be considered, and then only rejected when the local or general conditions render all efforts futile. It not infrequently happens that a meningitis is but the terminal stage in a hopeless lung, peritoneal, or bone tuberculosis.

Intervention here, as elsewhere, must be based on the conditions present. When there exists a localized, circumscribed meningeal tuberculosis, with definite focal symptoms, operative interference offers the only radical means of betterment. Again, in accidental changes incident to a healed circumscribed tuberculosis, this surgical removal may prolong life, or improve the patient's condition. As in the pleura or peritoneum, so here the tuberculous irritation of the serous membranes results not infrequently in excessive fluid exudate, the presence of which soon results in destructive changes in the nerve tissue pressed on. Here mechanical means offer the only practical hope—hence the spinal aspiration of Quincke becomes a therapeutic measure.

Unfortunately, the disease in nearly half the cases results in an occlusion of the *iter a tertio* by an involvement of the choroid plexuses; hence intracranial pressure cannot always be thus reduced. We are then compelled to employ cranial drainage in one of several ways. In the babe, tapping the ventricles through the lateral angles of the fontanelle; in those requiring it a trephine opening with extracranial drainage, after the author's method, or subdural drainage after Ballance, has given beneficial results. This emphasizes the fact that we have a chronic diffuse, as well as an acute tuberculous meningitis. To the former group most cases of hydrocephalus belong.

To reduce the pressure from the accumulated fluids, Ballance has recently recommended the suspension of a small right-angled tube from

the dural membrane, one end of the tube being inserted into the lateral ventricle, the other remaining subdural, thus converting an internal into an external hydrocephalus. The writer devised years ago an almost identical procedure, the chief difference being that the tube was flanged, the flange resting on the external surface of the parietal bone, through which a drill had made a perforation just large enough to permit of its passage into the ventricle. By this means the fluids escaped into the cellular tissues beneath the scalp, causing an edema of the same, slowly and gradually relieving the pressure, and benefiting the patient, with less chance of displacement of the foreign body. Mikulicz reported several cases treated by this method. Spontaneous cures, though rare, have been observed.

Laboratory examination of the fluids removed by any of these methods have proved the desirability of the procedure, since infective elements and their toxic products are thus eliminated. Moreover, cytologic examinations and inoculations have demonstrated some curable forms, while yielding confirmatory evidence.

THE BRAIN

Tuberculomas (*Solitary Tubercles*)—those large, usually solitary masses of tuberculous matter composed of nodes undergoing characteristic degenerative changes—are found embedded generally in the nervous tissue. They have their origin always in the meninges, a fibrous strand form which can almost invariably be demonstrated. They may be multiple (twenty per cent). Although multiple, one tumor alone may produce symptoms, the others being "latent" or in "negative" zones. They may attain the size of an orange. They rarely follow surgical tuberculosis, and are of very slow growth. In their growth they press apart the adjacent nerve structures, have but little intimate connection with them, and, when producing localizing symptoms, have been successfully removed, the patients living one, two, four, six, and even eight years. They occur more frequently in the cerebellum.

Alessandri reports twenty-one cerebral and five cerebellar tuberculous tumors operated on with rather favorable results in the cerebral cases. Greater fatality attends the cerebellar tumor, due to (1) late interference; (2) deep situation; (3) undeveloped technic.

They produce symptoms common to all brain tumors (headache, papillary edema, choked disk); they may also produce focal symptoms; and in addition they will probably show a reaction to either Calmette's, v. Pirquet's, or Wright's tests for tuberculosis.

While presenting in their clinical history or physical examination evidences of other healed or active tubercular foci, the less marked the

general pressure symptoms, the more sure the local diagnosis. Too much emphasis cannot be laid on the significance of the early appearance of the focal symptoms, but in the absence of all localizing symptoms the tumor probably occupies one of the negative zones—e. g., right frontal corpus striatum, lenticular nucleus, anterior portion of the optic thalamus, or cerebellar hemisphere.

What has been said of the brain and its membranes holds true of the *spinal cord* and its coverings. In most cases of spinal tuberculosis the disease is an extension from above. About sixty-five cases have been collected in which it was localized in the cord. When so localized the symptoms are dependent on the parts involved. A tuberculoma here produces similar pressure symptoms to those of any other tumor, and when its presence can be diagnosed, offers greater hope of benefit than the tumors more commonly found in this region.

CHAPTER V

INTESTINAL TUBERCULOSIS

By L. L. McARTHUR

General Considerations.—Intestinal infection by the tubercle bacillus is now so well recognized that discussion is limited to when, how, or why it occurs, and the influence of treatment on it. In commencing the study of intestinal tuberculosis we are confronted at once by the natural subdivisions pathologists make, based on their findings.

I. Primary Intestinal Tuberculosis.

II. Secondary Intestinal Tuberculosis.

With many thousands of autopsies and hundreds of observers to confirm the observations, it has been demonstrated that, while the vast majority of cases of intestinal tuberculosis are secondary, there are quite a number of cases of true primary intestinal tuberculosis without other discoverable lesion. With the reopening of the question as to the atrium of infection in the individual, the later, more painstaking observations show that through the intestinal tract a far larger proportion (twenty-one per cent) of cases occur than had been deemed possible.

A definition of the term "primary" should here be given. Several years ago the writer stated that it is impossible, clinically, to predict the location of the absolute primary focus, and call that "primary" which is the apparent site of inception of the disease. Thus an orchitis, a Pott's disease, or hip disease may clinically be primary, while the post-mortem findings prove them secondary to some focus in a mediastinal or cervical lymph gland or other unsuspected area. The term primary must now be limited to those cases in which there is no other recognizable lesion from which the infection could rationally have occurred. The number thus to be classified is constantly increasing, while the number of cases of general tuberculosis in which the atrium of infection was the intestinal tract exceeds present belief. It will thus be seen that true primary intestinal tuberculosis must be due to direct infection of that tract by the ingestion of tuberculous foci, while the secondary occurs from the deglutition of infective matter coming from similar active processes above, in the same individual.

Practically, babes long at the breast and milk-fed infants are the only

ones afflicted with true primary intestinal tuberculosis, since they are the ones exposed to the most commonly infected foods, and their intestinal tract is least resistant to such invasion. While both Eisenhardt and Fenwick found only 1 case in 1,000 autopsies on adults which they considered primary, they also demonstrated by the same series that few cases of tuberculosis of the respiratory tract escape an ultimate secondary intestinal tuberculosis. Eisenhardt in his 1,000 autopsies of tuberculous adults found 563 cases with intestinal infection; 489 had cavities and 74 had none. Indeed, the intestinal lesion is usually overshadowed by the pulmonary disease. But inasmuch as the presence of cavities—and, therefore, bacilli in the sputum swallowed—determines so regularly the intestinal infection, the absence of cavity formation will have a decided prognostic value in those cases coming to the surgeon for aid. These persons will, as a rule, be over twenty-five years old, and more often males than females.

From the painstaking monograph of Fürst one can secure a complete *résumé* of all the arguments for and against the intestinal tract as the primary route of infection in tuberculosis. The occurrence of intestinal tuberculosis being admitted, there is need for a clear understanding of how, where, and why this happens. Fürst tabulates the various modes by which the human being may become infected with tuberculosis, as follows: (1) Aerogenous; (2) enterogenous; (3) amygdalogenous; (4) lymphogenous or hemogenous; (5) dermogenous; (6) hereditary and congenital. Of these the first two are of special interest.

Aerogenous.—The respiratory tract, so universally accepted in the past as the principal route of invasion, has of late been proved by experiment, by clinical observation, and by postmortem findings not to infrequently be enterogenous in origin (*vide* Baumgarten's cases and experiments).

Recently there has arisen almost an antithesis in the belief held for the twenty-three years following the reports of Koch and Baumgarten of their discoveries, as to the infectivity of the milk of tuberculous cows. This is consequent on the reopening of the question by Koch himself, and the apparent assumption by him of a diametrically opposite view to the one first held. I say apparent, because he does not deny what he formerly claimed to have demonstrated, but he insists that the transference of the bovine type of infection to the human being is of far less frequency than he had taught.

Though the identity of the human with the bovine tubercle bacillus had been universally accepted, Koch's London address threw a shadow of doubt over the matter. There has been a division of scientists into two groups, with Koch heading the dualists. Even the dualists hesitate to advocate the abandonment of all those precautionary inspections

of meats, milks, and animal foods for which every government has made such splendid provision in their bureaus of animal industries. The innumerable researches and reinvestigations stimulated by this reopening of the question have demonstrated the intimate relationship between the two organisms, and have proved the possibility of enterogenous infection with the bovine organism, which is distinguished by the term "pearl" bacillus, because it induces "Perlsucht"—bovine tuberculosis.

It is at postmortem examinations that the greatest surprises, the strongest confirmations, the surest evidences of the atrium of primary infection manifest themselves. They furnish us with our most positive proofs as to the varying modes of invasion. In this disease the pathologist can frequently determine which is the older and which is the more recent process. Cicatrices, calcifications, encapsulations, and adhesions are evidences of the older process, while the miliary bodies and acute inflammatory processes are of more recent origin. These pathologic anatomic findings give indubitable proofs that figures alone must convince us that the enterogenous infection is not only possible but proved.

Often an autopsy held on children dead of measles, scarlet fever, or diphtheria, has revealed an unsuspected tuberculosis, while affording a convincing proof of both the site of the primary invasion, and after that, equally instructive evidences of its latency, duration of virulency, or spontaneous healing.

The painstaking investigations of Kossel, Nageli, Heller, and v. Hansemann have given the astonishing result that every second or third individual has, at some time in his life, acquired and recovered from a tuberculous infection. This without its having ever been suspected or detected. But these evidences have, by their site and solitary character, demonstrated beyond cavil the door of entrance: for example, the finding of solitary caseous lymph glands in the mesentery beyond the cicatrix of a healed intestinal ulcer, but without other discoverable forms, is proof of a primary enterogenous infection.

A review of the records of autopsies made (as was done by Fürst) shows a great variation in the presence or absence of tuberculosis, but by eliminating all probabilities of error, and accepting only the most conservative estimates as to frequency, it is very evident that in every 100 postmortems held on children dead from whatever cause, 29 or 30 deaths have been from tuberculosis.

Frequency.—During the first three months of life intestinal tuberculosis has scarcely ever been observed. In 446 postmortems held from 1892 to 1902, Trepinsky failed to find a single case in the first four weeks, but found one in the fifth to the ninth week. From the third month to the third year there was a rapid increase in frequency, diminishing again from the fifth to the tenth year. Nearly half the children dissected dur-

ing the first five years of life were found to be tuberculous. He has also shown by a composite report of fifty competent pathologists that the frequency of infection through the respiratory, as compared with the alimentary tract, is greatest in children: Under two years, as 9 to 5 (Symes and Fischer, based on oldest forms); two to twelve years, as 4.71 to 1; thirteen to twenty-four years, as 3.87 to 1; twenty-five to thirty-six years, as 9.66 to 1. While these figures show the relative frequency of the process, they do not demonstrate the primary character of intestinal tuberculosis.

While conceding the great preponderance of the aerogenous, amygdalogenous, and lymphogenous mode of infection, 4.5 per cent of primary intestinal invasion is none the less significant. It having been demonstrated (Ribbert, Orth, Spengler) that primary bronchial lymph-gland tuberculosis does occur without pulmonary involvement, the parallel possibility—primary mesenteric tuberculosis—seems equally possible. Indeed, Freisich and Schulz have come to the conclusion that bronchial lymph-gland tuberculosis is not necessarily proof of respiratory-tract infection, and Behring claims that the primary character of pulmonary invasion is very much overestimated. Such extreme views as Brandenburg's, that "for pulmonary tuberculosis the intestinal source of infection is the most frequent," cannot yet be accepted as proved. Since Baumgarten has demonstrated that pulmonary tuberculosis can be induced through the uninjured urinary-tract mucosa, it is easy to conceive how the same thing may occur in the intestine. Finally, it can easily be comprehended how infective organisms, gaining access to the upper respiratory passages, may be arrested by the mucus, which, being swallowed, may induce an enterogenous infection (Buttersack).

Enterogenous.—The mere question of a primary enterogenous infection is of little moment if we fail to consider the question whether a food infected with bovine tuberculosis can produce tuberculosis in the human being. Can milk from tuberculous cattle produce the disease? When Koch, a quarter of a century ago, announced the discovery of the tubercle bacillus, he also suggested the great probability of danger of infection from tuberculous animals. This suggestion resulted in the systematic prophylactic examination of animals sold for food, their milk and its products. To-day he leads the opposition to this view, arguing that the bovine organism rarely induces tuberculosis in human beings. Investigations, experimental and clinical, made since 1901 show that this is not only possible, but probable. The instances quoted are isolated; still, the observers reporting them base their opinions on carefully studied cases.

Fürst collected and tabulated the reports of 160 undeniable primary intestinal tuberculous cases, some of which seemed indubitably due to

the bovine bacillus. He submits the histories, nature of lesions, and postmortem findings of some 30 other cases which he classifies as probably primary, but not proved, with a third group, of 23 cases, of general tuberculosis whose origin appeared to be, in the opinion of the pathologist, from a primary intestinal focus. Baumgarten demonstrated that the tubercle bacillus can and does pass through the intact intestinal mucous membrane to be arrested in the mesenteric lymph glands. Resistance to infection, however, must indeed be great, or the frequency of intestinal invasion in consumptives should exceed even the 56.3 per cent demonstrated by Eisenhardt. While the germicidal action of the digestive juices protects the adult against infection, in the child this action is not always active or present; hence the greater frequency in children of infection through this route. Simple ulcers, too, under these conditions, easily become the seat of infection; hence a simple appendiceal, typhoid, or other lesion becomes infected with tuberculosis. Again, the lymph follicles of the intestine permit the passage of these organisms, for the pathologist has found tuberculous mesenteric glands, tuberculosis of the chyle cistern, tuberculosis of the subclavian artery, of the right heart, and even, with normal bronchial glands, a pulmonary tuberculosis, as an end result of an intestinal tuberculosis.

Statistics demonstrate the atrium of entrance in many an intestinal (and lung) tuberculosis to have been through the mucosa. Lubarsch claims that there is primary intestinal tuberculosis in 21.2 per cent of all autopsies on tuberculous individuals, and in 4.7 per cent of all children coming to autopsy. Hof, by adding the undoubted cases of primary mesenteric tuberculosis to the others, puts this figure in the case of tuberculous children at 25.1 per cent.

From the following table it will be seen that while in two thirds of the cases the invasion occurs through the respiratory tract, the next important atrium lies somewhere in the intestinal tract.

	Respiratory	Alimentary
Carr	75.2%	19%
Kossel	59%	4.5%
Hof	56.2%	25.1%
Still	55.9%	25.5%
Nebelthau	34.6%	19.2%
Average	56%	18.6%

Two observations may here be referred to appropriately: (*a*) The experiments of Welseminsky and Basch, who proved the rapidity of the spread of the bacilli when introduced into the circulation, show that within a few hours the bacilli could be demonstrated in the milk.

(*b*) Roger and Garnier demonstrated the existence of tubercle bacilli in the milk of a tuberculous mother, both by feeding experiments and by postmortem examination of her child. It had a primary mesenteric tuberculosis.

Etiology.—It may be said that the deglutition of active bacilli is practically always the cause, and we are indebted to Bollinger for the demonstration that tuberculous food can induce a primary intestinal tuberculosis, even through an absolutely intact mucous membrane (Dobroklonsky); and Klebs called attention to the sputum as the etiologic factor of moment in secondary intestinal tuberculosis.

Any processes which disturb the integrity of the mucous lining of the intestinal tract will act as predisposing factors; hence diphtheria, gastric or duodenal ulcer, dysentery, typhoid ulcer, colitis, appendicitis (*et id genus omne*), are occasionally followed by such mixed infection. The writer has personally observed such implantation on a gastric ulcer, on a cholecystenterostomy union, and on the site of a simple appendicitis. Disturbances of the stomach, by permitting the infective elements to escape the bactericidal action of the normally acid gastric juices, are probably more important, and explain the rarity of tuberculous gastric ulcers, as well as the greater frequency of invasion in the young child. The mode of infection resembles, in many ways, that of typhoid, affecting usually the lower ileum and ileocecal region, through the solitary follicles or lymph glands, since it is lymphatic tissue chiefly for which the bacillus shows its predilection.

As in the passage of carbon particles through the intact mucosa of the lungs, by entrance into the lymph stomata on its surface, perhaps assisted by the ameboid movements of the phagocytes, so in the intestine, through corresponding stomata, the tubercle bacillus is carried to the near-by lymph glands. Thus the primary lesion will be seen in the lymph glands of the mesentery without a corresponding discoverable lesion in the mucosa. So many well-observed instances of this kind have now been recorded that those who formerly opposed such a possibility now freely admit that the primary atrium need not be so large as to be discoverable at the autopsy. The very fact that this is possible is a, if not the, determining factor as to which of the varieties of intestinal tuberculosis will ensue, for the mode of entrance determines the pathologic anatomy of the case, whether of the (1) ulcerative or (2) hypertrophic type.

Ulcerative.—When the site of invasion has been in Peyer's patches, or in the solitary follicles, there is a tuberculous infiltration of these structures which, following the usual course of that disease elsewhere, soften, caseate, and break down, with the resultant characteristic tuberculous ulcer, with undermined edges. These ulcers present many of the

characteristics of typhoid ulcers, and, like them, may lead to hemorrhage or perforation (five per cent). The ulcers are multiple, but usually not as numerous as in typhoid. There exists a predilection for the extension of the tuberculosis process in the course of the blood and lymph vessels; hence they lie transverse to the long axis of the gut, and when showing (rarely) a tendency to heal, induce a circular stenosis of varying degree. As before stated, while these normal anatomic structures form the usual site of invasion, many clinicians have observed the direct implantation of a tuberculosis on a simple inflammatory process, such as appendicitis, catarrhal colitis, typhoid ulcers, etc.

Hypertrophic Variety.—When, on the other hand, the infection has occurred through the unbroken mucosa into a lymph channel, and the infective elements become arrested in the submucous lymph glands, these undergo the well-known histologic changes, with infiltration of the serosa and subserosa. Together with this, an unexplained but very constant phenomenon is observed—i. e., instead of a breaking down of tissue, an immense deposit of fibrous tissue ensues, with very few miliary bodies. Tumor formation occurs, so pronounced as sooner or later to be discovered by palpation. Like all new connective tissue, it contracts as it ages. In its contraction there results the stenosis that plays so important a rôle in the symptomatology of this variety of tuberculosis. For anatomic reasons this stenosis occurs most often at the ileocecal junction, the resulting tumor requiring careful study to differentiate it from other neoplasms found in this region.

The symptomatology of this disease varies with the variety under observation, but so widely as often to escape observation until autopsy, presenting only the aspects of a profound anemia.

In the ulcerative form there may and usually do exist the symptoms common to chronic intestinal catarrh, with alternating diarrhea and constipation. Ulcerated surfaces, bathed continually by the passage of intestinal contents, naturally occasion abdominal, umbilical, or right iliac pains, often colicky in character. The more extensive and deeper the ulcerations, the more sensitiveness is there of the overlying peritoneal surfaces; hence tenderness on palpation is frequently present. Like typhoid ulcers, they are prone to bleed, though not usually to the point of exhaustion. Blood can generally be found in the stools, occult in character if the ulcers are few in number, small and situated high up in the small bowel, because mixed with the stool; evident, bright, and coating the formed stool when the ulcers are situated in the larger bowel. Bamberger calls attention to the sagolike bodies found in the stools, that are really broken-down miliary granules from the follicles and ulcer bases, in which, too, are to be found, more easily than elsewhere in the dejecta, the tubercle bacillus.

Such a symptom-complex, of any duration, should lead the observer to suspect the presence of tuberculosis, while, at the same time, trying to verify his suspicions by a careful search for the bacillus, as well as all the factors which enter into the clinical history of a tuberculous subject. The Mayos have shown that the tubercle bacillus can more easily be obtained from the secretions just within the sphincters.

Absorption of the toxins, here as elsewhere, provokes an evening rise in temperature of varying degree, and the constitutional disturbances are similar to those seen in tuberculosis in any other part. When the ulcerative process lies, as it sometimes does, in contact with the parietal wall, there results, as Vocht has shown, a peculiarly indurated plaque, the tuberculous invasion inducing changes identical with those occurring in the intestinal wall in the hypertrophic variety. On cutting into such a plaque for the first time, one is so absolutely nonplussed to find in the layers of the oblique muscles and peritoneum such a flat cartilaginous-like body that he may doubt his own powers of orientation. Wocht's plaques have been observed over the ileocecal region, along the colon, and in Douglas's pouch. Tillmanns also mentions having observed them.

In either variety the process is so chronic as to be significant. The ulcerative variety may induce adhesions and some thickening, but the hypertrophy characterizing the invasion of the bowel wall from the serous side is absent. The ulcers may lead to fistulæ, abscesses, and perforative peritonitis; hence these characterize the later stages. These ulcers show little tendency to heal, but occasionally, by doing so, induce sufficient stenosis to require operative intervention. The ulcerative variety is most often seen with an active tuberculous process elsewhere, especially in the lungs, while in the hypertrophic type usually no other active process can be found. So closely may the symptoms in the more extensive cases resemble appendicitis that Benoit has even proposed the terminology for the two types—(*a*) neoplastic, (*b*) appendicitic.

Objectively the hypertrophic tuberculosis resembles so closely the conditions seen in malignant growths of the ileocecal valve that many cases heretofore operated on and reported as such have since proved to be cases of hypertrophic tuberculosis.

In brief, then, the formation of a tumor at the ileocecal junction, with slowly oncoming stenosis, characterizes the hypertrophic variety. Macroscopically the tumor consists of an immensely thickened, hardened bowel wall at the ileocecal region or below, with often a distended and hypertrophied ileum above and an atrophic and collapsed colon beyond the growth, due to the stenosis, which makes its appearance much later, relatively, than in cancer. Adhesions of varying degree form; the corresponding mesenteric lymph glands enlarge, and the peritoneum in the

neighborhood of or covering the growth, on close inspection, shows miliary tubercles.

Location.—Great unanimity of opinion exists as to the seat of intestinal tuberculosis being in the ileocecal region (eighty-five to ninety per cent), where the longer contact with irritating decomposition produces the firmer consistency, the angular implantation of the ileum and its peculiar vascular supply, all combine to diminish resistance and to increase the trauma. The Peyer's patches and solitary follicles, most numerous in this area and which in the adult undergo involution changes, are peculiarly susceptible.

Mere tuberculous nodules and granulations, with accompanying involvement of the neighboring lymph tracts, first manifest themselves, spreading in the direction of the intestinal flow. Czerny, quoted by Senn, states that areas of ulceration are limited to one side of the ileocecal valve. With this the writer is not in accord, having seen ulcerations both above and below the valve. The stomach is practically immune to tuberculous ulcer.

Treatment.—The treatment of intestinal tuberculosis is both medical and surgical, medical only so far as the ulcerative variety is concerned, since the hypertrophic variety is uninfluenced by medication. When the ulcerative variety has failed to improve after a reasonable length of time under such hygienic care and medication of the alimentary tract as the judgment of a competent physician would dictate, and the pulmonary process is demonstrated to be not so active as to contraindicate all surgical interference, the surgeon should intervene. The nature of that intervention can only be determined after the nature, extent, and location of the disease has been demonstrated by laparotomy, and the physical condition of the patient has been considered. In general it may be stated as true that this class of cases, more than any other, withstands surgical insult better, and that these patients convalesce more smoothly from formidable surgical procedures; hence a boldness not otherwise permissible may be resorted to.

Surgical intervention will consist of (1) excision of the diseased area, or (2) its exclusion. Therefore, when the lesion is found in a patient who otherwise is in reasonably good condition, and when the lesion involves either the last twelve or eighteen inches of ileum, the ileocecal region, or the ascending colon, or all three, complete excision may be practiced with reasonable hope of recovery from operation and a symptomatic cure of the patient.

When the condition of the patient, for various reasons, contraindicates so radical a procedure, a diversion of the intestinal current by partial exclusion has, in the author's experience, proved an efficient measure. Putting the diseased part at rest, by the prevention of the passage of the

intestinal contents over the surface of the ulcerations, will, at times, ameliorate or cure the local processes, and restore the patient to apparent health.

When the hypertrophic variety is considered, we have as the principal symptom stenosis—slow, gradual, but increasing in severity until finally mechanical relief must be afforded. It is interesting and instructive that, as in the case of a heart suffering from valvular stenosis, there is, first, hypertrophy above to compensate for the gradually obstructing lesion, to be followed by a sudden dilatation when compensation fails; so in the intestine, the first urgent symptom may be the sudden appearance of obstruction, when the limit of compensatory hypertrophy above the stricture has been reached. The writer has more than once been called in cases of suspected appendicitis with tumor, when the trouble revealed itself as an hypertrophic stenosis at the ileocecal valve. With nothing in the condition of the patient to contraindicate it, a total ablation of the ileocecal region has been practiced with gratifying results. When, however, the stenosis had been of long standing so as to have greatly emaciated the patient, with consequent fecal vomiting, exclusion by anastomosis has given perfect results.

CHAPTER VI

TUBERCULOUS ISCHIORECTAL ABSCESS AND ANAL FISTULA

By LEONARD FREEMAN

It has been estimated that fourteen or fifteen per cent of anal fistulæ occur in tuberculous individuals, and that approximately five per cent of those afflicted with phthisis have fistulæ. It must not be assumed, however, that because a fistula occurs in a consumptive it is necessarily tuberculous. There is no reason why a consumptive should not have a simple fistula as well as anyone else, and perhaps more reason. In other words, a careful distinction is necessary between "tuberculous fistulæ and fistulæ in the tuberculous."

Pathology.—Tuberculous ischiorectal abscesses, which always precede the formation of fistulæ, are usually due to infection through the bowel, although they may arise from the prostate, from bone lesions, or even from local traumatisms. Although much has been said in favor of hematogenous origin, nevertheless the intestinal theory has been accepted almost universally. Chiari has offered a plausible explanation of the manner in which infection occurs by calling attention to certain diverticula which often exist in the mucous membrane just above the anus, and represent abnormally enlarged lacunæ Morgagnii. They are embedded in the connective tissue surrounding the bowel, and may penetrate between the fibers of the sphincter muscle. Fecal matter containing tubercle bacilli and other microörganisms enters these lacunæ, and if they are unusually deep and the drainage poor, inflammation may result and communicate itself to the surrounding ischiorectal tissues, thus giving rise to an abscess. The process bears a strong resemblance to the recently described "diverticulitis" (Mayo) which has been observed in the region of the sigmoid. In cases of pulmonary phthisis, tubercle bacilli which have been swallowed with the sputum may easily find lodgment, and it may be that contaminated food is an occasional carrier of the germs.

Symptoms and Diagnosis.—Tuberculous ischiorectal abscesses are usually more or less indolent in character, at times becoming quite large without causing a great amount of discomfort; but occasionally

they are acute, with marked local and general symptoms, indicating a mixed infection and leading to much uncertainty in diagnosis. Tuberculous fistulæ almost invariably occur in connection with pulmonary phthisis, but they are never the cause of the phthisis, nor do they influence its course for the better in any way. They may, however, react unfavorably on the lungs by adding new and debilitating complications; and it is not unreasonable to suppose that the annoyance of a bad fistula might turn the scale against an invalid where disease and resistance were evenly balanced, as is so often the case.

The appearance of the cutaneous mouth of a tuberculous fistula is often characteristic, in that the edge of the opening, which is usually large, is apt to be undermined, ragged, and livid in color, but this is by no means always true.

Ulceration of the skin frequently exists, together with "fungous granulations," and caseous deposits may occasionally be detected. The more active the process the greater the tendency toward ulceration, which may be very extensive. It has been asserted that tuberculous fistulæ are never surrounded by indurated tissue like the ordinary fistula, which is suggested as an aid to diagnosis. The truth is, however, that fibrous thickening is as common here as it is in tuberculosis elsewhere, representing the reaction of the part against bacillary invasion.

The discharge is apt to be scant and watery; but this is far from pathognomonic, as the secretions from simple fistulæ may be of this character, and in mixed infections with a tuberculous basis profuse suppuration may exist.

The indolence of the original abscess, together with a comparative absence of pain and tenderness, is always suggestive but not conclusive, and the same may be said of the presence of tuberculosis elsewhere, especially in the lungs. Some writers lay much stress on the absence of fat in the ischiorectal fossa, the laxity of the sphincter muscle, and the presence of a superabundance of long, silky hair; but these conditions belong more to pulmonary consumption in general than to tuberculous fistulæ in particular, and may be present when the fistula is a simple one.

The demonstration of Koch's bacillus is difficult, as in most surgical tuberculoses, and its apparent absence should not have too much influence on the diagnosis. The inoculation of guinea pigs with the discharge is more reliable, but it requires too much time and trouble to be employed frequently.

It can be understood from the above that many fistulæ cannot be recognized as tuberculous until after operation, when the wound refuses to heal in the ordinary manner. Hence, it may be best to treat every

fistula in a consumptive as though it were due to the tubercle bacillus, thus saving time and avoiding many disappointments.

Treatment.—Anal fistula was one of the first surgical diseases to receive recognition and intelligent treatment, Hippocrates using the ligature, and the Roman surgeons the knife, as is done to-day. It was observed, however, that although most fistulæ recovered promptly after operation, others did so very slowly or not at all, and that a number of the latter patients lost in health and often died of consumption. It was therefore assumed that all fistulæ were established by nature for the purpose of draining injurious "humors" from the system, and if closure were attempted, disaster would result. Heurteloup carried this idea to such an extreme that he actually advised the production of artificial fistulæ in consumptives.

Among the general public these erroneous notions are still prevalent. Physicians, however, now universally agree that most fistulæ should be operated on; but when tuberculosis of the lungs coexists, opinions are widely divergent, many still clinging to the statement of Sir Benjamin Brodie, that "in those cases in which a *fistula in ano* occurs in connection with some organic disease of the lungs or liver, I advise you never to undertake the cure of the fistula. No good can arise from an operation under these circumstances; but if you perform it, one of two things will happen: either the sinus, although laid open, will never heal as usual, or the visceral disease will make more rapid progress afterwards, and the patient will die sooner than he would have done if he had not fallen into your hands."

In looking over the modern text-books it is seen that some advise radical intervention in all cases where the lungs are not too extensively involved, while others are more or less conservative, even to the point of condemning all operations except incisions necessary to procure drainage. It is difficult to understand, however, why the lungs should be more unfavorably influenced by the excision of a local focus in the vicinity of the anus than by the removal of tuberculous glands of the neck, or an infected joint, kidney, or testicle; and for this reason, as well as from the accumulation of much clinical evidence, the opinion has gained ground that tuberculous fistulæ should be excised thoroughly, and that there is just as much reason for this, and just as little danger, as there is in the similar treatment of surgical tuberculosis elsewhere.

It must be clearly understood, however, that great care should be used in the selection of cases. Operations should not be done in the presence of advanced pulmonary trouble, or on those whose resisting powers are manifestly weak, especially if the local lesion is an extensive one; nor should they be attempted unless there is a fair chance for removal of all diseased tissue.

If an operation is undertaken, it should be thorough. Anything short of complete excision of the disease is often worse than useless, except in those comparatively rare instances where intervention is for the purpose of securing drainage only. Simply slitting up the sinus, as in ordinary fistulæ, even when followed by curettement or the use of the thermocautery, may be sufficient in certain cases, especially in those having a strong tendency to spontaneous healing, but a cure cannot be relied on. Mere dilatation of a sinus is useless, as is also the employment of chemicals, electrolysis, and the écraseur. Even the use of the elastic ligature is not advisable, in spite of its strong recommendation by certain authors.

Although tuberculous fistulæ sometimes are made to heal when treated like ordinary fistulæ, the best operation is complete excision, with immediate closure of the wound. In the majority of instances primary union will occur, Sternberg, for instance, having obtained it in 82 out of 105 cases; but if inflammation should result, part or all the wound can be reoperated, and treated as if an operation for an ordinary fistula had been done, when the healing will be satisfactory if the disease has been removed radically.

If possible, operations should be done early, before extensive involvement of surrounding tissues takes place, the most favorable time being after the original abscess has been opened and as soon as the superabundant inflammation and infiltration have subsided, leaving a well-defined fistulous tract which can be extirpated thoroughly with the least sacrifice of tissue.

The most favorable cases are those with latent pulmonary lesions and good resisting powers, especially when the fistula is surrounded by considerable fibrous tissue. If rapid ulceration is present, with lack of induration, the outlook is correspondingly bad. Good hygienic surroundings and a favorable climate add to the probability of recovery.

The reasons for an unfortunate result are several: (1) Operations, sometimes prolonged and bloody, are done on patients in advanced stages of consumption whose progress would inevitably be downward, whether operated on or not, and to whom any surgical intervention must be harmful. (2) Fistulæ are often forerunners of exacerbations of pulmonary disease, which would surely follow even if an operation were not performed. (3) Incomplete operations are frequently done, followed by prompt recurrence.

The method of operating should permit of thorough exposure and removal of everything which is diseased. An excellent procedure is to introduce a pair of bullet-forceps through the well-dilated anus, grasping the mucous membrane above the fistulous opening in the bowel and pulling the internal end of the fistula well out of the anus. Then, by means of several sharp hooks inserted around its margin, the wound

is opened out to the fullest extent and made easily accessible, much as in plastic operations on the perineum, and with knife and seissors the entire fistulous tract is excised, going well beyond the infected portion. Plastic operations, or even skin-grafting, may be necessary to cover the denuded area. The opening should be closed, if possible, with silkworm-gut sutures, which enter the skin on one side of the wound, pass beneath it within the tissues, and appear on the other side. These should not be tied too tightly. The bowels should be locked for four or five days and the sutures removed in from seven to ten days. Local or spinal anesthesia may be employed when indicated.

CHAPTER VII

TUBERCULOSIS OF THE PERITONEUM

By L. L. McARTHUR

Occurrence.—So rarely does the primary invasion of the peritoneum by tuberculosis occur that most authorities regard it as secondary to some other process in the abdomen. Citation has been made, because of their rarity, of cases in which it apparently was primary. Many such cases on further analysis have shown a preceding trauma, with rupture of a softened mesenteric (Heintze) or mediastinal gland (Baumgarten), with immediate infection of the peritoneum as the chief symptom following the injury. Bendorf's case of a mesocecal tuberculosis, with general peritoneal tuberculosis extending therefrom, without other discoverable lesion, is the best authenticated case, and appears to have been one of those intestinal invasions without lesion of the mucosa. Statistically (Bircher), less than two per cent of all cases of this affection have been regarded as primary.

Attention is thus early called to the secondary nature of the peritoneal tuberculosis, because both its diagnosis, prognosis, and treatment will in part be influenced by the determination, when possible, of the primary focus. Some of these cases being removable surgically, a cure of both the primary disease, as well as the secondary complication, may be affected by operation. The lymphogenous mode of infection being the chief one, mention only need be made of the ileocecal tuberculosis, tuberculosis of female genitalia, tuberculosis of the vas deferens, and mesenteric gland tuberculosis to appreciate the varying atria of infection.

Classification.—Considerable difficulty exists in classifying the varying manifestations of this disease of the peritoneum, since neither on pathologic nor clinical basis can it be sharply separated into distinct varieties. The safest course is to regard it as a widely varying manifestation of a single process whose severity, extent, and character are dependent on many factors.

On a pathologic basis it may be divided into two general groupings: (1) Simple tuberculosis of the peritoneum; (2) tuberculous peritonitis.

In the former we find the peritoneum studded with small gray miliary nodules, unaccompanied by practically any clinical symptoms. The miliary bodies may be localized or general, numerous or discrete. This variety, seen and described almost solely by the pathologist, has but little clinical interest. If there is an exudate, it may escape detection until the pelvis overflows (1,500 c.c., this being about the quantity which may escape casual observation).

Tuberculous peritonitis is often seen by the surgeon. It produces many clinical symptoms requiring surgical intervention. As a direct outgrowth of this systematic surgical interference there has been evolved a necessary subclassification based on the clinical findings, viz.: (*a*) The adhesive tuberculous peritonitis; (*b*) the ascitic tuberculous peritonitis; (*c*) the cheesy tuberculous peritonitis.

Since the observation of a cure by laparotomy, made by Spencer Wells, the ascitic form has been the one of most interest both to the internist and the surgeon, for with this type they have had their greatest encouragement based on results. With these surgical experiences, too, has come the knowledge that while in the ascitic variety most cures were to be obtained, other varieties exist not always to be recognized prior to operation. This necessitated the addition of (at least) the other two classifications above given.

The *ascitic form*, as its name implies, is associated with a fluid exudate, of varying quantity and quality, of large or small albumin content, clear or cloudy, colorless or straw-colored, with or without fibrinous flakes, even bloody or purulent. The fluid, usually free in the general cavity, is sometimes found encysted, when the differential diagnosis may be rendered very difficult. The peritoneum, thus bathed, and held apart by fluid, is, as a rule, free from adhesions, while presenting the characteristics attending the invasion by tubercle of serous membranes elsewhere. The degree of infectivity of the fluid also varies extremely, sometimes requiring most careful animal inoculations to demonstrate its tuberculous character.

An experimental basis (Levi-Sirugue) has been brought forward explaining the variations as dependent on the degree of virulence of the organisms introduced. Thus the cheesy—richest in bacilli—is the most severe, while the ascitic or the dry forms contained few bacilli, and these were of reduced virulence.

Symptomatology.—The ascites rounds out the belly often to marked prominence; although generally free, the fluid may be encysted and unilateral. The navel may protrude in a somewhat significant manner, its veins, through an inflammatory process, making an omphalitis, to which B. Yeo has called attention. Later, intestinal fistulæ may develop at this site and the ascitic fluid may escape. Occasionally the ascitic fluid

escapes into an intestinal perforation. This Czerny has named the death sign.

The *fever* is of the same irregular character seen in other similar processes. *Pain* is positive, and present in eighty per cent; is sometimes general, at other times localized—e. g., in the vaginal vault (Murphy) or in the intestines. *Vomiting* is not infrequent. The interference in motility caused by the peritoneal involvement leads to constipation, cramps, and diarrhea. The latter is perhaps due to the putrefactive changes likely to occur in stagnating intestinal contents. Similarly, involvement of the vesical peritoneum gives vesical pain without urinary pathologic findings. Sweating may be a symptom. Mesenteric and inguinal glands may become involved.

In the third form, accompanied as it is by little fluid exudate, the tuberculous masses can usually be palpated, irregular in position, outline, and number; the omentum often becomes caked, can be palpated, is usually somewhat mobile, and emitting a peritoneal friction on auscultation. No age is exempt, from the newborn babe to the aged, but the greatest frequency is between twenty and forty.

A remarkable discrepancy has been noted between the relative frequency in the male and female, when the clinical are compared with the dead-house data, surgeons generally agreeing that the disease is observed three times as frequently in the female as in the male, while the pathologists reverse these figures. It is probable that the origin in or the early involvement of the female genitalia produces conditions more amenable to surgery than in the male, and hence more females come to operation.

The Adhesive Form.—On the other hand, the adhesive form may result in an almost total obliteration of the peritoneal cavity, cementing the abdominal organs into a single mass, so that the greatest difficulty is experienced by the surgeon in orientation. The mass made by these adhesive invasions sometimes deceives so thoroughly that operative interference for suspected tumor only then reveals its true nature. If effort be made to separate the same, even with the greatest care, fistulæ may result because of the extreme friability of a tuberculous intestinal wall.

The third form, of cheesy tuberculous peritonitis, possibly only a terminal stage of the previous form, is characterized by those degenerative changes which mark the terminal stage of tuberculosis anywhere —i. e., soft, gray, cheesy tubercles, covering both parieties and peritoneal surfaces of the abdominal organs. Both the adhesive and the cheesy types have proved themselves decidedly less amenable to surgical interferences than have the ascitic, since fistulæ, abscesses, and other complications are frequent sequences of even a simple exploration.

All three varieties are but stages of one and the same process. All three may exist in the same case; as early as 1869 the elder Klebs suggested a similar classification.

For years it has been known that there could be produced experimentally a condition of the peritoneum so closely resembling peritoneal tuberculosis that clinically, by autopsy or microscopic examination, it could not be differentiated. Bacteriologic and inoculation experiments alone could determine the noninfectious nature of these pseudotubercles. Clinically, this condition has been observed as induced by a ruptured echinococcus cyst, by distomum, by echinococcus hooklets, and by cholesterin crystals. To it has been given the name foreign-body tuberculosis. It is of such rarity that it deserves but passing mention, though its recognition might spare the patient much mental as well as physical suffering.

Diagnosis.—In an ailment appearing in so many forms, having its origin in so many different foci, mimicking almost every abdominal disease, it is not strange that until recent years its differentiation was difficult or impossible. With the newer methods of the laboratory added to our established methods it has now become possible to determine at least the presence or absence of a tuberculous process with reasonable accuracy. Something might here be said in this regard.

(1) *Tuberculin* (Koch, Wright, v. Pirquet, Calmette). (2) *Inoculation.*—When Koch first presented his discovery of the remarkable influences of tuberculin, use was made of it both as a diagnostic and therapeutic measure. Unfortunately, the results were often disappointing, dangerous, or doubtful. Later workers, like Wright, have shown that much can be determined by a study of the blood in relation to the capacity of its leucocytes to ingest tubercle bacilli (opsonic index), and through tuberculin in minute doses to improve this capacity. Eighty-six per cent of cases can thus be determined.

V. Pirquet has likewise devised an ingenious and safe method of utilizing tuberculin as a diagnostic measure, the accuracy of which is peculiarly great in children, and sufficiently so in adults to be a confirmatory aid. Its application has been elsewhere described.

Calmette's method, known as the ophthalmo-reaction, is dependent on the conjunctivitis provoked in the eye of the tuberculous, when a drop of a one-per-cent solution of tuberculin is instilled. So active is this reaction in the tuberculous that it is advisable to dilute to a greater degree than one per cent, and to advise the patient of possible discomfort.

A series of tests was made in my laboratory by Dr. Mary Lincoln, to determine the relative values of the cutaneous tuberculin test (v. Pirquet), the conjunctival tuberculin test, and the tuberculo-opsonic index in the diagnosis of tuberculosis.

The following table gives the results of these tests on three classes of cases:

Classes of Cases	Cutaneous Test		Conjunctival Test		Tuberculo-Opsonic Index (1.)		
	Number of Cases	Positive	Number of Cases	Positive	Number of Cases	One or more I Above or Below Normal I	Two or more I Above or Below Normal I
Pulmonary Tuberculosis, Stage III.	79	46%	87	36%	74	70%	34%
Bone and Joint Tuberculosis.....	47	80%	54	88%	60	61%	37%
Nontuberculous Clinically.....	32	1%	34	0.03%	34	40%	10%

Inoculation methods as now practiced in pathologic laboratories enable us (when possible to secure some of the suspected exudate) to determine the infectivity of an exudate much earlier and more surely.

Treatment.—How changed is the opinion as to the curability of tuberculosis of the peritoneum can be appreciated by those long in practice. From being considered an incurable condition, either by physician or surgeon, it has been turned over to surgery because of demonstrated cures in a very large percentage of cases (sixty to seventy per cent). Reclaimed by the internists as possible of cure without operation, the position now is that a selection of cases should be made, some being distinctly amenable to one, some to the other form of treatment. Since pathologists have proved ninety per cent of these cases have other lesions, attention must be directed to the entire disease, and not solely to the peritoneal manifestation. Therefore, all of the modern means of combating this disease should be employed. By this is meant more the hygienic, climatic, and atmospheric influences, the actinic rays of the sun and the Roentgen ray, rather than medicaments. Though many of these, too, may prove aids to convalescence, less dependence should be placed on them than in the past.

In an average case, there being no condition requiring early surgical interference, the internist should be given an opportunity to apply the best-known methods. If after the lapse of six to eight weeks distinct improvement is not demonstrable, the case should then be transferred to the surgeon. Although it is impossible definitely to state which patients should be operated and which should not, we can say that operation is indicated in (1) the distinctly ascitic cases; (2) cases with a remediable local lesion—e. g., tuberculous appendix, tuberculous

cecum, tuberculous genitalia, etc.; (3) cases that have failed to improve under the accepted modern methods.

Condensing the results of the innumerable operative procedures which have been evolved from the theories, practices, and experiments, one can say that simple median incision, with irrigation, gives the best results. This implies the escape of the ascitic fluid, flushing with a sterile normal salt solution, emptying the same, and hermetic closure of the abdomen. All the variations of this procedure have been carefully analyzed (Bircher), with the conclusion that this simple procedure described gives the best results. When the type of the case varies from the usual, then some special procedure may become necessary, in which event much must depend on the surgical judgment of the operator.

CHAPTER VIII

TUBERCULOSIS OF THE GENITO-URINARY SYSTEM

By LEONARD FREEMAN

GENERAL CONSIDERATIONS

Numerous observations seem to prove that tuberculosis may occasionally have its primary seat in the genito-urinary system, in the kidneys, testicles, seminal vesicles, prostate, or bladder. In the vast majority of cases, however, it is secondary to some other focus, usually in the lungs, which may be small or latent, thus easily escaping attention.

Theoretically, infection may take place in several ways—(1) through the blood, (2) through the lymphatics, (3) by contiguity, or (4) through the urethra, uterus, or Fallopian tubes—but there is good reason to believe that it seldom occurs except through the circulation. At various times attention has been called to the urethra and uterus as possible channels of entrance for the tubercle bacillus, although little or nothing has been demonstrated in this regard.

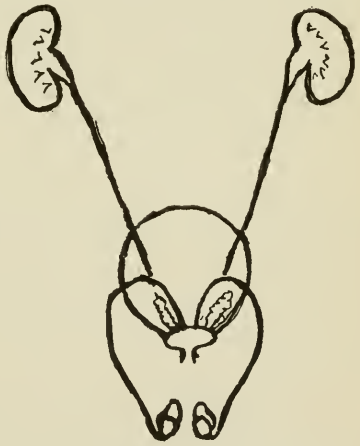


Fig. 181.—Indicating how the Urinary Group of Organs (Kidneys, Ureters, and Bladder) is Pathologically Distinct from the Generative Group (Testicles, Vasa Deferentia, Seminal Vesicles, and Prostate), with the Bladder as a Central Point.

In considering the origin and progress of infection in the male, the bladder may be regarded as a central point surrounded by the kidneys, testicles, seminal vesicles, and prostate; the generative organs, including the prostate, forming one group, and the urinary organs another (Fig. 181). In the female the conditions are similar, the uterus, tubes, and ovaries taking the place of the prostate, seminal vesicles, and testicles.

It was formerly taught that tuberculosis nearly always began in the bladder or prostate, and from there extended up the ureters to the kidneys, or down the vasa deferentia to the testicles (Guyon); but recently these views have been questioned by Baumgarten, Kümmel, von Bruns, and others, who maintain that exactly the reverse is true. By means of numerous experiments on rabbits, conducted during the course of several years, Baumgarten and Kramer, corroborated by Giani, have demonstrated that, although extensive tuberculosis of the bladder often followed the injection of tubercle bacilli through the urethra, in no instance and under no circumstances did the disease ascend to the kidneys or descend to the testicles, even after as long a time as a year and a half; while, on the other hand, when tuberculosis of the kidneys or testicles was first produced, it readily infected the bladder. In other words, the tubercle bacillus follows the course of the secretions and excretions in the genito-urinary system, up the vas deferens and down the ureters. It may also be said, with much probability, that in case the invasion takes place through the lymphatics of the ureters and vasa deferentia, its progress will be similar, owing to the distribution of the lymph vessels. As reasons for this tendency of the tubercle bacillus to float with the current only may be mentioned its lack of voluntary motion and its inability to multiply in the excretions and secretions of the body, as do many other microörganisms.

Hence, it is maintained, from experimental and clinical findings, that primary infection of the bladder occurs rarely, if at all; but tuberculosis has its origin, in the great majority of instances, in the kidneys, and occasionally in the testicles. Early nephritic involvement, however, is often difficult to detect without skilled cystoscopic investigation, owing to its painless, insidious character, thus causing the attention of both physician and patient to become concentrated on the secondary lesion of the bladder.

A strong clinical point in favor of the above views is the fact, supported by innumerable observations, that tuberculosis of the bladder has a marked tendency toward recovery when a diseased kidney or testicle is removed.

TUBERCULOSIS OF THE TESTICLES

This is nearly always secondary to tuberculosis elsewhere, although many observations seem to show that it may occasionally be primary. It has even been maintained that the germs can exist in the testicles at birth, but this is, perhaps, doubtful. It is true, however, that infection sometimes appears in those who are otherwise in perfect health and from whom no tuberculous history can be obtained, either as regards themselves or their family.

Tuberculosis of the testicle occurs very frequently during the age of greatest sexual activity, although it may appear in later life or even in old age. It is seen in children, and has occasionally been reported in infants. Those cases which exist as part of a general miliary tuberculosis will not be considered here.

As exciting causes of more or less moment may be mentioned injury of the testicle and gonorrheal epididymitis; but, as both occur with such frequency, it is difficult to determine their true weight as etiologic factors; although it must be admitted that the experiments are quite convincing in which tuberculosis of the testicle has appeared following crushing of the organ in infected animals.

Pathology.—The tuberculous process almost invariably appears first in the epididymis, rather than in the body of the testicle or in the vas deferens, although the latter structure often becomes secondarily infected. Occasionally, however, the body of the testis may be the seat of the primary lesion. The belief is steadily gaining ground, and is now quite generally accepted, that the tubercle bacillus reaches the epididymis through the blood, the anatomic arrangement of the vessels being favorable to its lodgment and growth. This view, strongly supported by experiments on animals and by clinical observation, is diametrically opposed to the teaching of Guyon, which was formerly universally accepted, in which infection was supposed to descend along the vas deferens from the bladder, prostate, or seminal vesicles. The question is of much importance in its bearing on treatment.

The lesions manifest themselves in the epididymis as a local disseminated tuberculosis, or, which is more frequently the case, as nodules of considerable size made up of conglomerations of small tubercles. Caseation and liquefaction are apt to occur as in tuberculosis elsewhere (Plate III, Fig. 2). The disease may secondarily invade the scrotum or the body of the testis, usually producing, in the latter situation, sufficiently large disseminated tubercles to be easily discernible on section of the organ. The process generally spreads up the vas deferens, manifesting itself either as more or less uniform thickening, or as isolated nodules, which can be detected by palpation. In advanced cases the whole testicle may be converted into a large indurated mass, to which the infiltrated and livid skin is closely adherent, and throughout which exist caseous masses and liquefied tuberculous foci in a matrix of fibrous tissue. Chronic fistulæ frequently form, which discharge pus and caseous material. It is not probable that living tubercle bacilli often find their way into the seminal fluid, or that infection of the ovum from this source is greatly to be feared (Orth).

Symptoms.—As in many other tuberculous lesions, the disease usually develops so slowly and painlessly that it may reach quite an advanced

stage before it is accidentally discovered as a hard nodule in the epididymis. It may be, then, that some injury to the organ leads to the detection of the trouble, and is erroneously assigned as the cause. Further progress, which may be rapid, but usually extends over many weeks, months, or even years, is characterized by increase in the circumference of the nodule, accompanied often by the formation of a hydrocele of moderate size. The skin of the scrotum becomes adherent, brawny, and of a dark-red or livid color, followed by the perforation of a tuberculous abscess. Persistent and annoying fistulæ are thus formed, through which secondary infection takes place, and which discharge pus and caseous *débris,* and through which may protrude masses of unhealthy granulations ("fungus of the testicle").

Involvement of the vas deferens takes place sooner or later, although it may be long delayed. It can easily be felt as a uniform thickening or as separate nodules (Plate III, Fig. 2), and is generally more pronounced in the lower portion, although this is not always the case.

The disease also manifests itself in an acute form; either primary, or secondary, to an already existing nodule. In such cases the epididymis is rapidly invaded by disseminated tubercles, which cause swelling, accompanied by pain and fever. In fact the process may be so acute as to closely resemble an attack of gonorrheal epididymitis, with which it is easily confused.

In ordinary chronic tuberculosis of the testicle, general symptoms are trivial or absent, unless mixed infection supervenes; but in the acute form a considerable rise in temperature and acceleration of the pulse may occur, accompanied by severe pain. A certain amount of mental depression may exist, such as is found with other affections of the genital organs. The sexual capacity is seldom affected.

Although tuberculosis almost always begins in but one testicle, the opposite organ frequently becomes infected sooner or later. According to Kocher, this occurs in at least seventy-five per cent of the cases, while von Bruns places the number at fifty per cent, the disease being already bilateral in about one fourth of the patients operated on. If involvement of the other testicle follows unilateral castration, it almost always does so within three years.

Diagnosis.—Tuberculosis is easily differentiated from most tumors, because it occupies the epididymis and not the body of the testis, although a tense hydrocele may cause some confusion; but between tuberculosis and the indurations remaining after gonorrheal inflammation the diagnosis is, at times, extremely difficult, especially as tuberculosis seems frequently to follow gonorrhea. The presence of tuberculosis in the lungs, kidneys, or bladder, and particularly the existence of nodules in the prostate, seminal vesicles, and vas deferens, is of much assistance

in arriving at a correct conclusion. Involvement of the skin, with or without chronic sinuses, is almost pathognomonic. Fibroid tumors of the epididymis are usually known by their smoothness, their regularity of outline, and the absence of a tendency to increase much in size. Cysts are elastic and smooth, and if large they are translucent.

When syphilis affects the body of the testis it is not difficult to distinguish it from tuberculosis, which begins in the epididymis; but when gummatous lesions exist in the latter structure, the differentiation is not so easy. A diagnosis can usually be made, however, by noting the history of syphilis, the lack of bladder symptoms and the absence of nodules in the prostate, seminal vesicles, and vasa deferentia, as well as the absence of sinuses and of adhesions of the scrotal integument. In case of doubt, a course of syphilitic treatment should always be employed before operation is considered.

Treatment.—It is undoubtedly true that tuberculosis of the testicle may recover spontaneously, or at least become indefinitely latent, especially in a favorable climate and under good hygienic conditions; but this cannot be depended on, and it should not be lost sight of that, while awaiting such recovery, the disease may spread along the vas deferens to the seminal vesicle, the prostate, and even the bladder, thus getting beyond surgical control and doing more or less irreparable damage. Hence, as a rule, the most reasonable procedure is to remove the testicular focus as early as possible. Even if the disease is supposed to progress from above downward, instead of from below upward, it must be admitted, from the statistics of von Bruns, Simon, and others, that the higher lesions, even when far advanced, are favorably influenced and often cured by the removal of the testicle.

If it is decided to use expectant treatment, as is invariably done by some surgeons in incipient cases, and in those in which the involvement is not great, the best hygienic surroundings should be secured, including a favorable climate, if possible. Local applications are of little or no service, the whole question hinging rather on the resisting powers of the patient, which should be increased in every available way. In this connection the vaccine therapy of Wright is attracting much attention, and undoubtedly deserves consideration, although its reliability has not yet been sufficiently demonstrated. It should be used as an adjunct to surgery rather than as a substitute for it, and may be employed in mild or incipient cases, or in those which are no longer active, whether sinuses exist or not. But where there is much diseased tissue, or the process is an active one, surgery should have the preference. As a precaution against relapses, it is always in place following operative measures.

Bier's treatment should also be mentioned, in which constriction of the upper part of the scrotum is made by means of a rubber band applied

so as to secure a moderate degree of venous hyperemia of the testicle; or a similar result may be obtained by the employment of a dry cup, this being especially useful where a sinus exists. In this location, however, the reliability of Bier's methods is not so well established as in parts where they can be applied more accurately.

The injection of various medicaments, such as chlorid of zinc or an emulsion of iodoform, directly into the epididymis, cannot be recommended, owing to the great pain which accompanies the procedure and the rarity of favorable results.

At the present time operative treatment undoubtedly offers the best prospect of permanent cure, and should be considered in every case unless decided contraindications exist, such as extensive and hopeless tuberculosis elsewhere. By this is meant a radical operation, although palliative procedures are occasionally advisable where radical measures are contraindicated, owing to the general condition or prejudices of the patient.

Palliative Operations.—These usually consist in the curettement and cauterization of sinuses, and the injection into them of various antiseptics. A curettement should be thorough, with the object of removing all caseous and infected material, although it is seldom possible to accomplish this with satisfaction. If cauterization is resorted to, it should be repeated frequently, employing either the electrocautery, chlorid of zinc, or ninety-five per cent carbolic acid. For purposes of antiseptic irrigation, tincture of iodin, of considerable strength, is of service. Resection between ligatures of a portion of the spermatic cord, as advocated by Mauclaire, is no longer practiced.

Radical Operations.—These are of two kinds—(1) resection of the epididymis, and (2) castration.

Epididymectomy deserves consideration in every case, especially when both testicles are diseased. The loss of both organs is not without occasional psychic effect, and the "internal secretions" are of importance. The sexual desires and capacities also suffer after double castration; occasionally, however, to a surprisingly small extent. The fact that many patients will readily consent to resection of the epididymis, while rejecting castration with horror, necessarily has much weight in the choice of an operation.

The removal of the epididymis has its justification in the fact that tuberculous processes almost always begin in that portion of the testicle, involving the body of the organ later, if at all. This is well shown in Plate III, Fig. 3. Hence there must be a time when epididymectomy is just as effective as castration, and it should be the operation of choice in cases which are seen early and in those which have not progressed too far. Von Bruns, who strongly favors castration, asserts that the body of the

testis is involved in about 18 per cent of the cases at the end of two months, 24 per cent after three months, 40 per cent after six months, and 60 per cent or more in later cases. Even if this is considered to be an extreme statement, it emphasizes the fact that, if epididymectomy is resorted to, it should be done as early as possible. As it is often impossible to determine the exact condition from external inspection, every operation should be at first exploratory in its nature. It may even be necessary to cut into the body of the testis, as one would slit open a kidney at an autopsy, before a decision can be reached between epididymectomy and castration.

In operating, the epididymis should be resected as a whole, even though but a portion is diseased, carefully respecting the vascular attachments of the cord to the body of the testis. If involvement of the tunica albuginea exists, castration should be strongly considered. As a rule the vas should be isolated up to the internal ring, and divided as high as possible, as in castration (Plate III, Fig. 3). It has been claimed that if the vas is implanted into the remains of the epididymis, or into the body of the testicle, through an incision in the tunic, its permeability to spermatozoids may be restored. This can be tried in appropriate cases, when the vas appears to be free from disease, but the outcome is, to say the least, questionable, and the chance of cure lessened.

When the body of the testis is left, a certain amount of atrophy usually takes place; but in many instances it is but slight—an argument in favor of the persistence of the function of "internal secretion." If the tuberculous process recurs, castration can then be done, and in the meantime there is but little risk of extension of the disease because of the absence of the vas.

Castration is necessary in most advanced cases, and should always be done when the body of the testis is involved. Without question it gives a somewhat greater assurance of cure, although it often seems desirable to run a slight risk in this regard in an attempt to save a portion of the testis, especially when one organ has already been lost. The force of this statement is apparent when we remember that orchiectomy can be done later if necessary.

There is no question that the removal of a tuberculous focus in one testicle lessens the danger of disease in the other; but that castration has any advantage over epididymectomy in this regard has not been proved. The proportion of permanent cures following castration lies somewhere between 40 per cent and 60 per cent. That the cures from epididymectomy, in well-selected cases, are much less than this has not been demonstrated, and is not probable.

The technic of castration is of the utmost importance. The vas must always be followed to its exit from the internal ring, splitting, for this

purpose, the aponeurosis of the external oblique, as in an operation for hernia, so as to expose the inguinal canal freely. With a piece of gauze the peritoneum is then stripped back and the vas pulled out of the ring as far as possible before its ligation and division. The lumen of the stump should be treated with carbolic acid or the actual cautery. Von Bünger's suggestion, that the vas be pulled out until it gives way at some point higher than could otherwise be reached, has not been extensively adopted, for fear of hemorrhage, or of tearing the peritoneum and giving rise to tuberculous peritonitis. Although these dangers are probably small, it is nevertheless true, as observed by the writer, that the duct is apt to give way at a point weakened by disease, so that little, if anything, is really gained (Plate III).

In advanced cases, where the scrotum is adherent and tuberculous, the greatest care must be used to remove all suspicious tissue in order to avoid recurrence. This sometimes necessitates the resection of practically one half of the scrotum, it being better to remove too much than too little. Even after the most careful operation, sinuses of more or less importance may develop, but they usually heal spontaneously.

Following castration, when healing has been definitely obtained, a quantity of paraffin may be injected into the scrotal tissues so as to simulate the absent testis, and to some patients this is a source of much consolation.

Whether much is gained by following the disease into the seminal vesicles and prostate is open to discussion. The operations for this purpose are so extensive and severe, and the good to be obtained so problematical, that most surgeons hesitate to undertake them, especially as improvement often results from orchiectomy or epididymectomy alone. The injection of an emulsion of iodoform into the seminal vesicle through the lumen of the severed vas can do no harm, and may be of service.

TUBERCULOSIS OF THE SEMINAL VESICLES AND PROSTATE

It was formerly thought that tuberculosis of these organs was usually primary, but the experiments of Baumgarten and the clinical observations of von Bruns, and others, seem to show that it nearly always ascends through the vas deferens from the epididymis. Less frequently it may directly extend from the bladder, following renal tuberculosis. The improvement which so often follows castration is certainly suggestive of the secondary nature of the disease. Infection of the bladder from the seminal vesicles and prostate sometimes occurs in advanced cases, although vesical tuberculosis generally descends from the kidneys.

Symptoms.—These may be comparatively slight, unless the posterior urethra is involved, when frequent and painful urination occurs. Pus often is present in the urine, although tubercle bacilli may be difficult to find. The usual signs of chronic seminal vesiculitis are present, such as irritation of the neck of the bladder, pain in the rectum, perineum and back, together with various nervous phenomena, more or less pronounced. A small amount of purulent urethral discharge is often observed, which may contain bacilli.

Indurations can be felt in the prostate and seminal vesicles, the latter being sometimes greatly distended by tuberculous material. Abscesses may develop in the prostate and discharge themselves into the urethra or into the bowel, or through the skin near the anus, simulating an ordinary ischiorectal abscess.

Treatment.—Treatment should generally be initiated by the removal of the tuberculous focus, which usually exists in the testicle, by epididymectomy or castration, this being often followed by more or less rapid improvement. If abscesses form, it may be advisable to open and thoroughly curette these through the perineum, although annoying sinuses are apt to develop and persist indefinitely. Prostatectomy is occasionally resorted to, but is of doubtful utility in most cases, as the wound often becomes tuberculous and refuses to heal, thus leading to incontinence of urine. The removal of tuberculous seminal vesicles has been strongly advocated from various sources during recent years, some choosing the abdominal route, others the perineal, and still others the sacral; but the operations are so severe, and the outlook for success comparatively so poor, that most surgeons hesitate to advise these procedures, except in occasional cases and under particular circumstances.

Local medication through the urethra, or by means of urinary antiseptics, is of no service; but hygienic measures should always be employed, and an appropriate climate is undoubtedly beneficial. The vaccine therapy of Wright should be considered, although its reliability has not been proved.

TUBERCULOSIS OF THE KIDNEY

The attention which has recently been given to renal tuberculosis has shown this disease to be more frequent than was formerly supposed. Senn estimated that one out of every eighteen consumptives suffers from some form of genito-urinary tuberculosis, and in the Pathologic Institute at Prague foci were demonstrated in the kidneys in 5.6 per cent of the autopsies on adult tuberculous patients. The percentage in children, according to Gillet and Barthez, is 15.7.

That the disease is sometimes primary in the kidneys cannot be de-

nied; but, in the great majority of instances, it is undoubtedly secondary to pulmonary or other foci, which are frequently, however, slight in degree or latent.

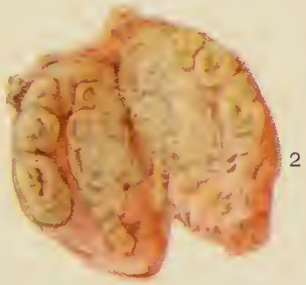
Little is definitely known as to why tuberculosis should locate itself in the kidney in one case and not in another. Traumatism, however, may play a part; and it has been noted that the disease is apt to appear in kidneys which are abnormally movable, although this is by no means always true. The writer has noticed the frequency with which the trouble seems to occur in so-called latent pulmonary tuberculosis; but this may be more apparent than real, because in marked pulmonary involvement attention is concentrated on the lungs to the neglect of other lesions.

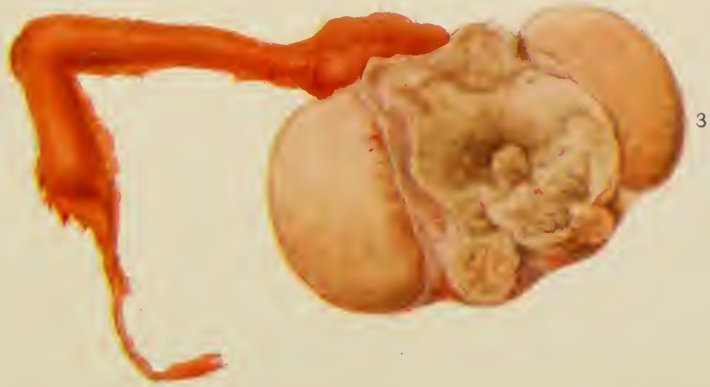
Pathology.—The hematogenous origin of tuberculosis of the kidneys is now commonly recognized, contrary to the older idea that infection took place through the ureters. This modern view is well expressed by Schéde, who says, "It has been proved beyond all doubt, and is generally accepted, that the principal mode of infection is through the blood." Clinical experience is furthermore strongly supported by the interesting experiments of Baumgarten already referred to (see page 778).

When the disease is not part of a general miliary tuberculosis, it almost always begins in one kidney. Israel estimates that this is true in ninety per cent of the cases, while others place the proportion still higher. This has been learned at the postmortem table rather than in the operating room, for by the time a case comes to autopsy the second kidney may have become infected through the blood, or through the bladder from the kidney first involved. This unilateral origin is of the utmost importance as regards surgical treatment.

The parenchyma is usually affected first, often just beneath the capsule, and from here the disease spreads downward to the pyramids, pelvis, ureter, and bladder, with more or less rapidity. It may be disseminated throughout the kidney, which is generally the case, or confined to some particular portion. Smaller nodules combine to form larger ones, which undergo caseation and lead to the development of tuberculous abscesses, perhaps of large size (Plate III, Fig. 1). In advanced cases the whole organ may be little more than a sac containing caseous material and pus. Perinephritis is not uncommon, and is sometimes of that variety in which the kidney becomes embedded in a thick mass of dense fibrous tissue. Perforation of the capsule may lead to perinephritic abscesses, often multiple, and sometimes of great size.

Involvements of the pelvis present themselves as ulcerations of a characteristic tuberculous appearance. Disease of the ureter manifests itself by thickening of the wall and ulceration of the lining membrane, but strictures seldom result.





1.—Tuberculosis of the Kidney, showing Cavities and Nodules.
2.—Tuberculosis of Lymph-node, showing Caseous Nodules.
3.—Tuberculosis of Epididymis, Incision through Normal Body of the Testis.

Symptoms.—These are often so surprisingly slight, unless secondary infection occur, that the disease may be overlooked until it is far advanced. There may be no pain or discomfort of any kind as far as the kidneys are concerned, the first manifestation of the disease being felt in the bladder or observed in the cloudy or bloody urine, which was well illustrated in the case from which the kidney shown in Plate III, Fig. 1 was obtained. Often the bladder is treated for a long time before the kidneys are suspected. Even the urine may give no indication of what is going on, because the disease is confined to the parenchyma without invasion of the pelvis. The writer has seen extensive involvement of the kidney, with an abscess as large as a walnut, while the urine remained perfectly normal.

As a rule, however, more or less pronounced pain and tenderness are felt about the kidney and along the ureter, with occasional attacks of spasmodic renal colic. Reflex pain may be felt in the bladder, testicle, or thigh, often leading, in the case of the bladder, to unnecessary operations and prolonged treatment before the real seat of the disease is discovered.

The *urine* nearly always shows characteristic changes. It is usually watery in color, abundant, and of low specific gravity. In fact, a "diabetes insipidus," especially in early and middle life and in those with suspicious histories, should always direct attention to possible tuberculosis of the kidneys. Pus is always present when the kidney lesion communicates with the pelvis, and when it is present in sufficient quantity it causes a uniform cloudiness of the urine. The reaction is acid, except in the presence of certain mixed infections. It must be distinctly understood, however, that the character of the urine is but a poor index to the extent of the disease, because the kidney may contain many small and even large abscesses which have no connection with the channel of excretion. Blood is often seen in the urine, either microscopically or macroscopically; in fact, decided renal hemorrhages are not infrequent, and may even be the first symptom to attract attention. Urinary casts are not found as often as might be expected, and particles of caseous material are encountered in advanced cases only.

The demonstration of tubercle bacilli is not easy, even when the disease is marked and the urine full of pus; for instance, none were found in the urine coming from the kidney illustrated in Plate III, Fig. 1. Repeated and careful search is necessary, by the most approved methods, carried out with due reference to possible confusion with the smegma bacillus. It is better to centrifugate the entire urine for twenty-four hours, according to the Forsell-Gregerson method, than it is to depend on a single specimen. The apparent absence of bacilli should not influence the diagnosis too strongly. In fact, a good rule to follow is to regard

every chronic inflammation of the bladder as tuberculous, especially in early and middle life, unless it can be proved to be due to other causes. Even the history of a recent gonorrhea should not be given too much weight, as this disease seems frequently to prepare the soil for a subsequent tuberculosis.

Mixed infection is common, especially with the colon bacillus and the pus-forming microörganisms, and may be regarded as the source of much of the pain and discomfort. It may occur spontaneously or be caused by instrumentation.

The general symptoms are not marked at first, although a slight evening rise in temperature may exist, with a corresponding fall to subnormal in the morning; but in advanced cases, especially those with marked involvement of the bladder, emaciation exists, accompanied by constitutional disturbances due to sepsis, pain, strangury, and loss of sleep, the condition of such patients being pitiable in the extreme. In spite of the fact that the disease sometimes becomes latent for longer or shorter periods, and occasionally disappears without treatment, the large majority of cases pass from bad to worse, with all the suffering incident to renal degeneration and harassing cystitis, until death affords relief. It should be noted, however, that much of the actual suffering usually comes not so much from the kidneys as from the bladder.

Diagnosis.—This is made by taking into consideration the history of the patient; the watery, acid, purulent urine containing tubercle bacilli and, perhaps, blood; the ulcerated condition of the bladder, and the presence of tuberculosis in the lungs, testicles, seminal vesicles, or prostate.

There is often much diagnostic confusion between tuberculosis and stone, particularly in early stages of the disease and when nephritic colic exists. The intelligent employment of the X-ray is then of the greatest importance, and much dependence may be placed on the conclusions thus obtained. If the tubercle bacillus cannot be detected microscopically, animal inoculation should be tried. There is always much uncertainty regarding the use of tuberculin for diagnostic purposes, owing to the usual presence of pulmonary tuberculosis.

The hemorrhage from malignant tumors and from certain forms of chronic interstitial nephritis may lead to mistakes in diagnosis, if the character of the urine is not repeatedly observed, and the bladder and mouth of the ureters carefully inspected with the cystoscope.

Treatment.—Internal medication is of little or no value, unless the vaccine therapy of Wright, which is at present attracting so much attention, prove to be of more service than is now accorded it. The ordinary urinary antiseptics often do more harm than good. General hygienic measures, combined with outdoor life in an appropriate climate, are certainly of some use, although they cannot be depended on and should not

be persisted in to the exclusion of surgical intervention, if improvement is not rapidly obtained.

The accumulated evidence of many observers has demonstrated that early nephrectomy, before involvement of the bladder occurs, is the best treatment for unilateral renal tuberculosis, provided the general condition of the patient permit. It is not even permissible to temporize long with what appear to be mild or incipient cases, as the symptoms form an unreliable index to the extent of the disease, and while expectant treatment is being used, the trouble is often secretly progressing. Tuberculosis elsewhere, if not too far advanced, is not a contraindication to operation, because subsequent improvement often results. Especially is this true of the bladder, which may get better or recover, even in bad cases, after removal of the source of infection. An extreme instance is reported by Kümmel, in which there was present tuberculosis of both testicles, both seminal vesicles, the bladder, and both kidneys, together with pulmonary tuberculosis and a tuberculous periurethral abscess, the patient suffering great pain and prostration. The trouble seeming to center in the left kidney, this was removed. Immediately a marked improvement took place, the patient being relieved sufficiently to return to his work.

The principal thing to be kept in view when considering nephrectomy is the condition of the second kidney, which must be functionally sound, although the mere existence of albumen and casts does not necessarily contraindicate operation, provided the excretory power is good, because they may be due to the presence of toxins in the blood, and will disappear after the tuberculous organ is removed. As a rule the other kidney should be free from tuberculosis, although there is considerable clinical evidence to show that, even when both organs are diseased, the removal of the one which is most affected may have a favorable action on the remaining one. The weight of evidence is against partial nephrectomy, however enticing it may appear in theory, for it is impossible to be sure that all the disease has been eradicated, owing to its frequent dissemination in small and widely scattered foci. Nevertheless, it is interesting to note that Morris successfully excised a tuberculous focus from the kidney of a woman whose other kidney had previously been removed for the same disease.

Nephrotomy is never indicated, except for the purpose of relieving great suffering in those who for some reason cannot undergo nephrectomy. A cure cannot be expected, and a troublesome urinary sinus results.

Following nephrectomy, tuberculous fistulæ often persist in connection with the end of the infected ureter. Hence, theoretically, removal of the entire tube is indicated, as practiced by Kelly and Hunner. Prac-

tically this is not advisable, as it increases the extent and danger of the operation; and, in addition, the fistulæ usually disappear spontaneously in the course of time, although they often persist for many months. It is desirable, however, to cauterize the lumen of the ureter and fasten the stump in the lower angle of the wound, where it can be reached easily, and where it will do the least damage. Mayo advises the injection of a small amount of ninety-five-per-cent carbolic acid into the ureter, in order to disinfect it as far as possible.

In considering the question of operation, the most important points are: (1) Whether the disease is unilateral or bilateral; (2) if unilateral, which kidney is affected; and (3) is the second kidney capable of properly performing its function if a nephrectomy is done? In coming to reliable conclusions, the catheterizing cystoscope is almost indispensable. With it can be noted the condition of the bladder, and particularly the appearance of the ureteral openings. If the mouth of a ureter is swollen and red, and particularly if it is ulcerated, the corresponding kidney is almost certainly tuberculous. Sometimes blood or pus can be seen coming from the orifice. Catherization of the ureters furnishes evidence regarding nephritic conditions, and is practically devoid of danger of carrying infection to a sound kidney if the bladder is thoroughly irrigated and proper aseptic precautions are employed. The Harris and Luys segregators are also of service, and may be used in place of the cystoscope, in many instances, although their use is more painful, especially in the male, and the results are not so reliable.

When the bladder is irritable, ulcerated, and perhaps shrunken, a segregator, or even at times a cystoscope, cannot be employed. A general anesthetic, or spinal anesthesia, can then be considered, but this may also fail when the vesical conditions are particularly bad. Under these circumstances it has been advised to open the bladder above the pubes, and catheterize the ureters by direct observation; but a better plan, which is open, however, to error, is to make an exploratory incision over each kidney with the idea of removing the diseased organ at once, provided the other seems to be sound (Edebohls and Rovsing).

Many methods have been suggested for determining the functionating power of the second kidney, but none of them is entirely reliable. In fact, so eminent an authority as Rovsing has discarded them all in favor of the simple estimation of the solids, especially the urea. There are others, however, who claim great corroborative reliability for various tests. Cryoscopy, for instance, has been extensively employed. It consists in the determination of the relative density of the blood or urine by ascertaining the freezing point by means of appropriate apparatus. The temperature at which the blood should normally congeal is 0.56° C. to 0.57° C. A freezing point of less than 0.6° C. means that the second

kidney is not exerting its proper function, and a nephrectomy would be dangerous. Similar conclusions may be drawn from cryoscopy of the separated urines.

The renal excretory power may also be approximated with an accuracy that compares favorably with that of cryoscopy by feeding the patient a quantity of salt, and then determining the percentage of sodium chlorid in the blood or urine, which approximately corresponds to the amount of urea. This is determined by noting the hemolytic action of the blood serum or urine on the red corpuscles of normal blood (Wright). An increase of salt in the blood, or a decrease below two per cent in the urine, would indicate diminution in the function of the kidneys.

Experience has shown that but little confidence can be placed on the determination of the excretory capacity of the kidneys by the color of the combined or separated urines after the administration of indigo carmine or methylene-blue. The phloridzin test, based on finding sugar in the urine at varying intervals after the administration of the drug, is also unreliable. These various methods may be of service, however, as corroborative evidence.

TUBERCULOSIS OF THE SUPRARENAL GLAND

This form of tuberculosis is uncommon, and may exist with or without involvement of the kidney. When the function of the glands is sufficiently destroyed, pigmentation of the skin, gastro-intestinal symptoms, and asthenia may result (Addison's disease). If the diagnosis can be made, extirpation of the gland is the best treatment.

TUBERCULOSIS OF THE BLADDER

Tuberculosis of the bladder is seldom primary; in the vast majority of instances it descends from the kidneys, and occasionally ascends from the epididymis. In some instances, however, when the bladder is already extensively involved, the disease may creep upward through a dilated ureter to a sound kidney (Rovsing).

Symptoms.—The primary disease of the kidney is frequently so insidious and so free from objective and subjective symptoms as to be overlooked, and the entire attention of physician and patient is given to the bladder. Hence the rule that in every case of tuberculosis of the bladder, the condition of the kidneys must be thoroughly investigated. This is best done with the catheterizing cystoscope; but as a rough preliminary test, the bladder may be cleansed thoroughly by copious irrigations, and the urine collected within fifteen to thirty minutes. Under these circumstances but little pus will have had time to form

in the bladder, and if the urine is still nearly as cloudy as it was before, it is fair to conclude that the contamination is probably of renal origin.

The reflex phenomena are similar to those which are met with in other forms of kidney lesions, and are often misleading as to the location of the disease. In addition, irritative and inflammatory conditions may arise from the passage of contaminated urine through the bladder, and are difficult to differentiate from actual tuberculous troubles. They quickly disappear, however, when the source of contamination is removed.

Tuberculous ulcerations, beginning with the deposition of tubercles, usually start in the mucosa surrounding the mouth of a ureter. The orifice stands open, and appears red and swollen, and later ulcerated. Gradually the disease spreads over the trigonum, and may ultimately involve a large portion of the bladder. The symptoms are those of cystitis. They are at first slight, manifesting themselves in moderate irritation and frequency of urination; but as the disease progresses the inconvenience and suffering increase, especially if mixed infection occurs, until the patient becomes worn out and emaciated from pain, strangury, and loss of sleep. The bladder may become so shrunken that it will contain but a few drachms of purulent and bloody urine, which burns the urethra in its passage. There are few more pitiable objects than a patient in this unfortunate condition.

Sometimes the course of the disease is rapid, but usually it is quite slow, occupying months or even years in its development; but whether slow or rapid, it usually ends in disaster, although long periods of latency or even permanent cures are occasionally seen.

Diagnosis.—In tuberculous cystitis, the wrong diagnosis is so often made that it is, perhaps, best to regard every chronic inflammation of the bladder in young and middle-aged individuals with suspicion unless its origin is perfectly clear. The fact that the patient has had gonorrhea is not conclusive evidence that he may not have tuberculosis, and the same may be said of vesical calculus. The tubercle bacillus should always be sought for, but its apparent absence should not be taken into account too strongly. The inoculation of animals is much more certain than the use of the microscope. Ulcerations about the mouth of the ureters and in the trigonum can often be seen with the cystoscope. A watery, acid urine, containing pus but apparently no bacteria, is very characteristic, but alkalinity of the urine and the presence of numerous microörganisms often exist with tuberculosis, owing to mixed infection. The existence of tuberculosis of the lungs, testicles, seminal vesicles, or prostate may throw much light on the condition.

Treatment.—The first step in the treatment of tuberculosis of the bladder, when the disease has descended from a single kidney, should

be nephrectomy, when the general condition of the patient and the functionating powers of the other kidney permit. Without removing the source of the trouble, all efforts at treatment are generally unsuccessful, but following nephrectomy, a cure, or at least improvement, may confidently be expected. It is gratifying to note how completely even severe lesions of the bladder will disappear after removal of a diseased kidney—lesions which had long resisted other forms of treatment and which a short time ago were regarded as incurable. It is self-evident that the sooner the operation is done the more satisfactory will be the result; hence, early diagnosis and early operation cannot be urged too strongly.

Operations on the bladder itself, such as curettement, cauterization, and excision of ulcers, without reference to the kidneys, are almost useless, because of the likelihood of reinfection. Permanent suprapubic drainage may occasionally be desirable for palliation of symptoms where both kidneys are badly diseased or some other contraindication to nephrectomy exists. Removal of the bladder for tuberculosis should seldom, if ever, be done.

Local treatments by irrigation are of but little service, and are often harmful. When inserting instruments into the bladder, the most extreme care must always be employed to avoid the production of mixed infection. Solutions of nitrate of silver and potassium permanganate, which are so useful in ordinary cystitis, only increase the irritation in the tuberculous forms. Much use has been made of injections of a ten-per-cent emulsion of iodoform in olive oil. This floats on the surface of the urine, and the patient endeavors to retain the material in the bladder as long as possible by carefully passing his urine from beneath it. Although decrease of bladder irritation can sometimes be obtained in this way, the process can seldom result in cure, and has been largely discarded.

Quite recently Rovsing has recommended a method of treatment, the principal indications for which exist in those cases of ulceration which are primary or which stubbornly persist following a nephrectomy. His instructions are: "After washing the bladder free from pus, 50 c.c. of a warm, freshly prepared, six-per-cent solution of carbolic acid are injected. The solution is retained three or four minutes, when it returns through the catheter quite milky in color. This is repeated three or four times, until the fluid returns fairly clear, after which there should be no further irrigation. In order to lessen the pain, which is severe for two or three hours, a rectal suppository is employed, containing about one third of a grain of morphin." The treatment is repeated every second day at first, and then the intervals are lessened until a cure results, which requires at least a month, and often much longer. Fourteen out of nineteen cases were cured in this way.

TUBERCULOSIS OF THE URETHRA

Tuberculosis of the urethra generally occurs as an extension from the bladder, although it may arise from disease of the prostate or seminal vesicles. It seldom attacks the anterior portion of the canal. Little can be done in the way of treatment except the removal of the source of infection, which is usually effective.

TUBERCULOSIS OF THE GENITAL TRACT IN WOMEN

Like other forms of genito-urinary tuberculosis, this is almost always secondary to tuberculosis in other regions of the body. It usually originates in the tubes, where the arrangement of the capillary circulation favors the localization of bacilli, although it may appear first in the ovaries, especially in children. From the tubes the disease frequently invades the peritoneum, the uterus, and occasionally the vagina. It rarely, if ever, appears in the two last-named structures, except as a descending infection.

Pathology.—The pathologic lesions are those of tuberculosis elsewhere—small and large tubercles, ulceration, caseation, and the formation of tuberculous pus with which tubes or ovaries may become distended. The uterine cavity can exhibit extensive ulcerative or caseous changes, or it may be filled with so-called tuberculous granulations. The cervix, although rarely attacked, may ulcerate or become the seat of "tubercular fungus" in the shape of exuberant granulations. When the vagina is affected, which is uncommon, it is usually in the form of ulceration.

Symptoms and Diagnosis.—The symptoms resemble so closely those of other inflammatory lesions that the diagnosis is always difficult, and often impossible, prior to operation. The presence of tuberculosis elsewhere—for instance, in the lungs—especially in the young and where other causes can be excluded, should excite suspicion.

Treatment.—The essential feature in treatment is the removal of the original focus, which usually necessitates salpingectomy or ovariotomy. When this is done, the associated structures which may have become involved secondarily, such as the peritoneum and uterus, tend to improve spontaneously. Before salpingectomy is done, local treatment of the uterine cavity is of little service, but after a diseased tube has been removed, thus cutting off renewed infection from above, an energetic curettement, followed by the application of strong carbolic acid or tincture of iodin, will hasten recovery. Hysterectomy is seldom indicated unless extensive uterine disease is combined with tuberculosis of both tubes.

ADDENDA

By LEONARD FREEMAN

Summary of Surgical Tuberculosis, Presented at the International Congress, held in Washington, D. C.

Although many valuable and interesting contributions to the subject of surgical tuberculosis were presented, they were mostly in the nature of confirmations of existing facts and theories.

The necessity for outdoor and climatic treatment of surgical as well as of pulmonary tuberculosis was universally emphasized, quite epigrammatically by DeForrest Willard, who said that "twenty-five thousand doses of pure air in twenty-four hours are infinitely better than three doses of nauseous drugs that disturb the digestion." It was insisted upon, that although fresh air and climate might not alone be curative in many cases, nevertheless they must be considered as extremely valuable adjuncts to the other forms of treatment.

In spite of some encouragement in the treatment of tuberculous lymph nodes of the neck with the X-ray and with tuberculin, opinion was strongly in favor of operative intervention. Dowd reported 80 per cent of cures in 275 operations, with an additional 10 per cent of improvements, while the mortality was but 0.33 per cent. Charles Mayo thought that operations could often be avoided in children under eight years of age by the removal of foci of infection in the mouth and pharynx, together with appropriate hygienic measures.

The numerous papers and discussions on renal and vesical tuberculosis (Bevan, Rovsing, Illyer, Rhimer, Guitéras, Karo, etc.) lay stress upon the almost invariable hematogenous origin of the infection, its progression downward toward the bladder, and the desirability of early diagnosis and immediate nephrectomy before the occurrence of vesical involvement.

The unreliability of the vaccine treatment was admitted, without losing sight of its future possibilities. It can be employed with advantage in the treatment of inoperable cases, and as an aid to satisfactory convalescence after operation.

An important paper on the prevention, diagnosis, and treatment of tuberculous sinuses and abscess cavities was contributed by Emil G. Beck, of Chicago. The method consists in the injection into the sinus

or abscess of a paste composed of subnitrate of bismuth (usually thirty-three per cent) and vaselin. In sinuses, considerable pressure is employed during the injection in order to insure penetration of the mixture into the remotest parts of the tract. A skiagram will then reveal the ramifications of the sinus, which are often surprising in their extent and complexity. These injections also seem to possess remarkable therapeutic properties, Beck reporting 65 per cent of cures in 192 cases, with 25.5 per cent of improvements.

The opinion was generally expressed that the ocular and cutaneous tests for surgical tuberculosis are of much diagnostic and some prognostic value, although neither of them are infallible, being sometimes negative when tuberculosis is present and occasionally positive when no tuberculosis exists. The cutaneous test (von Pirquet) is probably preferable to the conjunctival, as it is safer and at least equally reliable. It was agreed that the old subcutaneous test should seldom if ever be used, because of the considerable risk attending such injections.

After referring to the investigations of Sauerbruch, Matas, and others in regard to operations upon the lungs under negative and positive pressure, Robinson, of Boston, perhaps voiced the general opinion by saying that "it can no longer be justly stated that tuberculosis of lung and pleura is out of reach of the surgeon, but the question remains an open one as to whether drainage or excision of tuberculous foci in the thoracic cavity can ever result in the removal of the infection."

The hematogenous origin of tuberculosis of the epididymis was emphasized, and conservative surgery (epididymectomy) advocated.

The increasing conservatism in the treatment of joint tuberculosis was mentioned and discussed, operations being much less frequent than they formerly were, and more and more stress being laid upon such measures as fresh air, climate, rest, Bier's passive hyperemia, injections, vaccine, etc.

APPENDICES

APPENDIX I

THE TUBERCULO-OPSONIC INDEX

By MARY C. LINCOLN, M.D.

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Technic

There is no absolute technic in the determination of the tuberculo-opsonic index. The index represents a comparison between the opsonins of normal serum and those of pathological serum; hence, consistency in technic is the real essential. Certain principles in the technic are salient, but the details of carrying out these principles must vary. Each opsonist works out his own best technic. The following is the technic as developed in our laboratory:

I. Blood Serum:

1. Wind bandage around finger and make puncture in side of finger tip with fine point of glass capsule.

2. Break off both tips of capsule (Fig. 1) and allow three to four large drops of blood to run in through curved end held immersed in drop of blood.

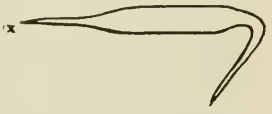

Fig. 1. — The Completed Capsule. Note the fine stabbing-point at the straight end *x*. (From *Surg., Gyn., and Obs.*, Dec., 1906.)

3. Seal straight end of capsule, cool, and shake blood down into sealed end.

4. Incubate three to four minutes.

5. Hang capsule by curved arm in centrifuge cup and centrifuge five minutes.

6. Break off curved end of capsule with pinchers and stand capsule upright in sand box.

II. Cream:

1. Let ten to twelve large drops of blood fall into test tube (capacity 4 c.c., diameter 1 cm.) three fourths full of citrate solution (0.5-per-cent sodium citrate in salt solution), gently tipping tube back and forth between each drop.

2. Centrifuge five minutes.

3. Aspirate supernatant citrate solution with suction curley pipette (Fig. 2), down to leucocyte zone.

4. Fill tube three fourths full of salt solution; mix by tipping tube gently back and forth.

5. Centrifuge five minutes.

6. Aspirate supernatant salt solution down to leucocyte zone.

7. Slant tube at angle of 30° in sand box and pipette off the remaining salt solution above the leucocyte zone just before using.

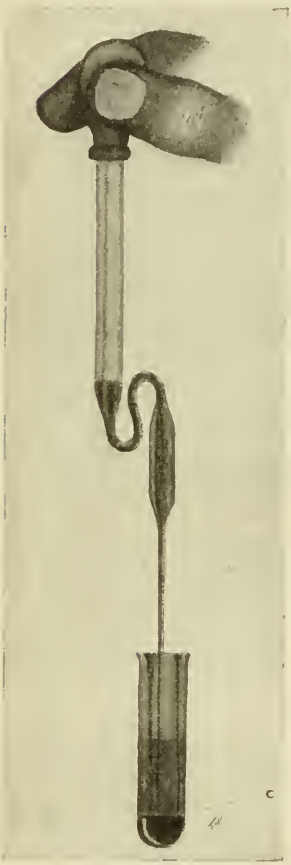

FIG. 2.—ASPIRATING SUPERNATANT LIQUID WITH SUCTION CURLEY PIPETTE DOWN TO LEUCOCYTE ZONE (*c*). (From *Surg., Gyn., and Obs.*, Dec., 1906.)

III. EMULSION:

1. Use residue from the manufacture of Koch's old tuberculin or growth on glycerin agar.

2. Wash residue free of glycerin by shaking up with a large volume of salt solution; filter; dry residue, and powder in mortar.

3. Grind powder in agate mortar one hour, adding 1.5-per-cent salt solution drop by drop, so as to keep the emulsion at the consistency of thin paste.

4. Dilute with 1.5-per-cent salt solution to a pearl gray; centrifuge one minute; dilute supernatant liquid to opalescence.

5. Determine strength of emulsion by "running through" and counting the number of bacteria per leucocyte; if more than 1.0 or 1.2, dilute and reëxamine.

6. Draw the standardized emulsion into spindle-shaped capsules (Fig. 3), aspirating with rubber teat fitted on one end of capsule. Seal end of capsule, remove rubber teat, and seal the other end of capsule.

7. Sterilize by immersing capsules in boiling water for one hour.

8. When ready to use, shake capsule vigorously and break off end with pinchers and stand upright in sand box.

IV. "RUNNING THROUGH":

1. Mark pipette (Fig. 4) with blue glass pencil 3 cm. from tip; fit rubber teat on

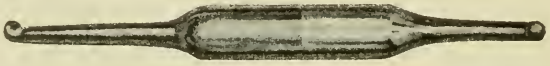

FIG. 3.—GLASS CAPSULE CONTAINING STERILIZED EMULSION OF TUBERCLE BACILLI. (From *Surg., Gyn., and Obs.*, Oct., 1907.)

end of pipette and compress teat slightly between thumb and first finger.

2. Aspirate one volume of cream (just touching tip of pipette to surface of leucocyte zone), a small column of air, one volume of serum, a small column of air and finally one volume of emulsion.

FIG. 4.—THE FINISHED PIPETTE, WITH RUBBER TEAT APPLIED AND A VOLUME MARKED OFF BY BLUE PENCIL (*x*). (From *Surg., Gyn., and Obs.*, Dec., 1906.)

3. Mix the three volumes with delicate control of rubber teat by pressing out on a slide each volume, raising pipette from slide to release each column of air, and then finally drawing the mixture into the middle portion of the capillary tube and sealing the tip. The rubber teat can then be removed and the pipette placed in the incubator.

4. Prepare pipettes in a similar way from all the patients' sera and from the normal sera.

Incubate fifteen minutes.

5. Break off tip of pipette with fine file; mix contents by blowing them in and out once or twice on glass slide; blow small drop on end of clean slide.

6. Make film by using smooth edge of a slide as a spreader and drawing this spreader, held at an angle of twenty degrees, very gently over the first slide. The drop of mixture should be small enough to allow the film to end on the slide and not be drawn off the slide by the spreader. The film may be made by using cigarette paper as a spreader instead of a glass slide.

V. STAINING:

1. Fix film in 7-per-cent mercuric chlorid. Wash in tap water. Blot in filter paper.

2. Cover film with carbol fuchsin and bring to a steam. Wash.

3. Decolorize in 2.5-per-cent sulphuric acid until very pale pink. Wash.

4. Decolorize further in 5-per-cent acetic acid until film is colorless. Wash.

5. Counterstain fifteen seconds in alkaline methylene-blue. Wash and blot.

VI. COUNTING:

1. Examine slide with low power of microscope. Select field with leucocytes abundantly but evenly distributed.

2. Examine selected field with oil immersion lens.

(*a*) Avoid clumps of leucocytes—e. g., leucocytes in contact.

(*b*) Pass leucocytes containing more than 8 bacilli.

(*c*) Count only the bacilli inclosed within the leucocytes.

(*d*) Count each fragment of bacillus as one, unless it is too small to be called a bacillus.

(*e*) Count the number of bacilli in 50 leucocytes.

(*f*) Divide the number of bacilli found in the case of the patient's serum by the number found in the case of the normal serum; the quotient is the opsonic index.

Suggestions and Specific Sources of Error

The secret of a rapid collection of blood is the making of a quick, firm plunge of the glass point into the finger, thus producing a puncture from which blood flows freely and which closes very quickly, usually at about the coagulation time of blood. To obtain a firm blood clot and a separation of clear serum, incubation of the blood before centrifuging is helpful. The blood may be collected in a fine U-tube instead of a capsule, the serum then separating in both arms of the tube. The patient's blood may be kept for two or three days in the ice box before examining, provided a normal blood is kept also under the same conditions.

Adequate washing of the leucocytes to remove all serum, careful sedimentation of the corpuscular elements of the blood so that there is a well-defined zone of leucocytes, complete removal of all the supernatant salt solution without disturbance of the corpuscles, are important details. Instead of fishing directly into the leucocyte layer, some opsonists aspirate the leucocytes and upper layer of red cells into a second tube, mix thoroughly, and fish from this "leucocyte emulsion." Fewer leucocytes per volume will be fished from the "leucocyte emulsion" than from the leucocyte layer. In my hands the "leucocyte emulsion" yields more leucocytes which are distorted and fragmented than does the leucocyte layer, due, I believe, to the additional manipulations of the leucocytes in preparing the "emulsion."

The most difficult part of the tuberculo-opsonin test is the preparation of a satisfactory emulsion. I have found that an emulsion prepared in the above manner (Technic III), with a density of about 0.8 to 1.1 bacillus per leucocyte, will be nearly free of clumps, and will have a nicely countable distribution of bacilli. Moreover, enough can be prepared at one time for a month, thus giving one a working emulsion of fixed strength for each day's running through.

Some opsonists use an emulsion of the density of 3 to 4 bacilli per leucocyte. Clumping of the bacilli is more common in such an emulsion, and should the patient's serum opsonize many more bacilli than the normal serum, many leucocytes would be crowded with bacilli too numerous to count. If such leucocytes are passed by and only those counted which contain a countable number of bacilli, the resulting opsonic index will not give a fair idea of the opsonins in the patient's serum.

Of the steps in "running through," the fishing of leucocytes to get a comparatively constant number on each slide and the making of uniform smears are of fundamental importance. A disturbing factor is the presence in some sera of an unusual amount of agglutinins, which cause marked agglutination of the erythrocytes, and may cause agglutination of the leucocytes with consequent interference with phagocytosis. The use of an autogenous cream is indicated in such cases.

Carbol fuchsin has long been accepted as the best stain for acid-fast bacteria, but the fact that there are strains of nonacid-fast tubercle bacilli has made some opsonists use Gram's stain. It is difficult to get a blood smear satisfactorily stained with Gram's stain, and it would seem that it possesses no superiority over carbol fuchsin in the opsonin test, inasmuch as the same bacterial emulsion is used both for the normal and the patient's serum unless one assumes some specificity on the part of certain sera in opsonizing nonacid-fast as compared with acid-fast tubercle bacilli.

The final step in the opsonin test—e. g., the examination of the slides—is fruitful of many possibilities of variations in results. It is absolutely necessary to fix some standard of counting such as is given in Technic VI, and to adhere consistently to it in counting all the slides. Moreover, it is only fair to the counter to number the slides so that their identity is unknown to him.

There are several ways of approaching the subject of the accuracy of the tuberculo-opsonic index. It has been definitely shown that the opsonic index is not a measure of the real opsonin content of the blood. It is necessary to know within what limits it is a comparative measure—e. g., a measure showing the relation between normal and pathological opsonins. The majority of opsonists test the accuracy by determining the extreme limits of the indices of normal individuals, the extreme limits of the counts of the same slide by the same and by different individuals, and of the counts of the same serum "run through" several times. Kjer-Peterson believes that the accuracy of the opsonic indices, like all observations, should be tested, not by the mathematical mean or the extreme limits, but by the mean error and the law of error. The value of the determination of the mean error and the application of the law of error would appear to be found only in a large number of observations made under the same conditions—for example, indices of normal individuals and of tubercular cases before tuberculin injections. The majority of counters commonly find a variation of 0.2 to 0.4, and not seldom of 0.6, in counting slides that should theoretically be identical or nearly so. Such results in themselves show the limitations of the index, show the impossibility of drawing any conclusion from indices which differ from one another by less than 0.4 or 0.6.

APPENDIX II

THE following leaflet, by Dr. A. S. Goodall, submitted in competition for the best educational leaflet for teachers, was awarded a gold medal at the International Congress on Tuberculosis of 1908:

TUBERCULOSIS

A Leaflet for Teachers

Tuberculosis is one of the oldest, most common, and most destructive diseases. One tenth or more of all deaths are caused by it. It is at the same time the most curable of all serious diseases. Its cause is the tubercle bacillus, discovered by Professor Koch in 1882.

This bacillus is a minute form of plant life, rod-shaped, motionless, living, and able to multiply with great rapidity by dividing into two again and again. Outside the body these bacilli do not multiply. They are killed by direct sunlight, fresh air, and other agencies. Direct sunlight kills them in a short time. Fresh air kills them slowly, in proportion to the degree of light and air. Boiling for half an hour will kill the bacilli, and if sputum is in small particles a shorter time will do. Five-per-cent solution carbolic acid mixed with equal volume of sputum will disinfect in twenty-four hours if occasionally stirred. It destroys bacilli in these smears of sputum quite quickly. Intense cold does not injure tubercle bacilli. In a dark, damp room they may live for months, while in a room with open windows and strong light they do not live many days.

Tubercle bacilli cannot be identified unless stained in a certain way. They look, through a microscope, like bits of red silk thread or like rows of little red beads. They are from $\frac{1}{10000}$ to $\frac{1}{5000}$ of an inch long and about one fifth to one fourth as wide. Over 16,000,000 could be placed in a single layer on a two-cent postage stamp. Flies carry tubercle bacilli about if they get at any sputum, and 5,000 bacilli have been found in one fly speck. Tubercle bacilli enter the body chiefly with dust in the air we breathe, on the food we eat, through tuberculous milk or meat; less often by kissing and through wounds in the skin. If breathed in, the bacilli may go at once to the lungs and cause disease, or they may be swallowed with the mucus from the throat and enter the stomach and bowels. They may then, like bacilli taken in with food, pass with the products of digestion into the circulation, to lodge in the lungs or else-

where. They may cause local disease of the digestive organs. The bacilli in sputum which is swallowed may thus cause new centers of disease. Food exposed to dust and flies or handled by unclean tuberculous persons may carry tubercle bacilli. Having entered the system, the bacilli may be destroyed if the person is healthy, they may multiply and cause tuberculosis, or they may lie dormant for long periods until the person's physical condition becomes suitable for their growth.

The tubercle bacillus found in man and that found in cattle and other animals are the same for all practical purposes, although differing in minor details. Tubercle bacilli from one creature may produce tuberculosis in any other creature.

Tuberculosis is communicable like typhoid fever, but not infectious like scarlet fever. The bacilli are thrown out of the body in the discharges coming from the diseased regions, the pus from glands or bones, the sputum from the lungs or throat. Sputum contains great numbers of bacilli; the pus not so many. Sputum carelessly scattered by tuberculous people causes the vast majority of cases of tuberculosis. Tuberculous milk and meat cause a small portion, and should be guarded against by maintaining and extending the official inspection of milk and meat.

The germs from consumptives are carried by the sputum, not by the breath. The breath itself is harmless. If sputum be carelessly allowed to scatter, it dries, becomes powdered and mingled with dust, and the bacilli are then inhaled by some one, or they settle on the food, and thus enter the digestive tract. If one expectorates upon the sidewalk or in a car, some one carries part of the sputum on his shoes or clothes into the house, where it will be inhaled. Dry sputum flies about and is very dangerous. Wet sputum clings where it lies, and is not as dangerous. Wet sputum in a cup is perfectly safe, so long as it is not spilled and is protected from the flies. The person who uses a sputum box is safe; the one who spits on the floor is dangerous, and should be ostracized. Putting pins, pencils, hairpins, or fingers into the mouth is liable to scatter bacilli about. It is dangerous to swap gum, or to eat apples, etc., that another has bitten.

In rare cases actual tuberculosis may be directly inherited. As inability to resist this disease, a predisposition may be inherited from parents who have tuberculosis, or who from any cause are weak or unhealthy. Generally, however, the extension of tuberculosis throughout a family is due to the transfer of bacilli from one member to another through improper care of the sputum.

Any form of sickness or bad living which weakens one's power of resistance renders one liable to tuberculosis. Overwork, poor food, lack of fresh air, drinking, excessive use of tobacco, vicious habits, late hours, and inherited weak constitution or unsoundness, all predispose. Poverty is the greatest predisposing cause, for the poor must contend against hard work, long hours, poor and often insufficient food, and overcrowded, unsanitary, poorly ventilated quarters.

No age is exempt, but tuberculosis is most common in adult life.

If the tuberculous discharges from a patient are properly collected and destroyed no danger results, and the patient is not a menace to nurse, neighbor, or fellow-workman. Discharges from glands, bones, etc., must be caught on copious dressing. These dressings should be wet before changing, to prevent any dry discharge from scaling off, and should be immediately burned. All sputum should be deposited in small burnable, waterproof paper boxes, carried about in a metal frame. The paper lining is to be renewed as often as necessary, at least once a day, and burned with its contents. It may be necessary to put some sawdust in a box to mix with the sputum, so that the latter may not run through the fire into the ashes. The metal container should be boiled, or soaked in five-per-cent carbolic solution. A pocket box of the above paper may be used, but does not hold much, and is not adequate if one raises freely. Both boxes are made by Seabury & Johnson, New York City, and the Aseptic Drinking Cup Company, Cambridge, Mass. If these cannot be afforded, a tin cup, part full of water, will answer, but the cup with its contents must be boiled vigorously for half an hour before it is emptied, and it must be covered while boiling, as otherwise some germs on the surface may remain alive. Metal pocket boxes may be used, but should be boiled. Sputum must never be put where it can dry and fly away, as by expectorating into a cloth or handkerchief. Nevertheless, a cloth should always be held over the mouth when coughing, to catch the fine spray that flies, and this cloth should be burned and a new one taken frequently.

Do not allow children in the sleeping room of a consumptive. In a consumptive's room use small rugs instead of carpets, sweep only with a broom bag dampened with five-per-cent carbolic solution, and dust with a cloth similarly dampened. Wash and boil both broom bag and duster frequently. Boil the bed linen. Use paper napkins at the table and gauze for handkerchiefs, and burn both. Knives, forks, spoons, etc., should be kept separate and well washed and scalded.

In the lungs the bacilli grow in the partitions between the air cells and passages, and as long as the membrane lining these spaces is intact no bacilli can get into the spaces and none can be found in the sputum, although the patient may be quite ill. It is dangerous to wait until bacilli are found before admitting that one has tuberculosis. The diagnosis can frequently be made upon other evidence before bacilli are found. The chance of cure is smaller after bacilli appear in the sputum. The bacilli do harm by destroying tissue and by poisoning the general system with soluble poisons. If recovery takes place the injured tissue is replaced by scarlike tissue.

The early symptoms of tuberculosis are slight cough, with or without expectoration, hoarseness, rapid pulse, slight fever (99.5° F., if occurring frequently, is suspicious), loss of weight and strength, and gastric disturbance. Any of these, if persistent, or recurrent, calls for prompt examination of the lungs and sputum by an expert. Later on come night

sweats, the hectic flush, and shortness of breath. Hemorrhage, pain in the chest, and cessation of menstruation may be early or late symptoms. Pleurisy generally means tuberculosis. Bacilli in the sputum constitute a positive proof. Their absence proves nothing. As the lungs extend to the sixth rib in front and the tenth rib behind, the clothes must be entirely removed to the waist, to allow complete and thorough examination.

No medicine has any effect upon the tubercle bacilli inside the body; nevertheless, consult your physician, for he can guide you safely past many pitfalls. Alcoholic remedies are injurious. Any medicine that disturbs digestion is injurious.

Fresh air, rest, and good food put the body in condition to overcome the bacilli. This is the treatment of to-day. Rest means absence of work, to sit or lie all day in the open air (in the yard, on the porch, or on the roof), to read, to sleep, to spend eight or ten hours nightly in bed.

Fresh air means to spend all day out of doors, and thus resting, not exercising. Rest has never hurt a consumptive; overexercise has killed thousands. Be out of doors, but be protected from storms and from wind. Sleep outdoors or with windows open both top and bottom. Occupy a room with windows on two sides if possible. On winter nights wear underclothing, stockings, a cap or hood, a cotton-flannel nightgown, and sleep beneath cotton-flannel sheets. Keep comfortable, but have the air. At night there is no air other than night air, and the fresh outdoor night air is infinitely better than the stale indoor night air.

Food should be abundant, varied, nourishing, well cooked, and attractively served. Milk, eggs, meat, bread and butter, cereals, fruits, vegetables—but little pastry or sweets. Do not stuff; eat as much as your stomach can manage, but do not overwork it. All this treatment one may have at home, and the home treatment is all that most patients can get. For many it suffices.

Removal to a suitable climate combined with this treatment gives one a better chance than treatment at home. Treatment at a sanatorium shows better results than treatment at a hotel or cottage in the same region. However, comfort and plenty at home are better than discomfort and want in the best climate. Climate alone will not effect a cure nor enable one to work. Like food and rest, climate is desirable, but the two former are to be chosen if one cannot afford all three.

A cold sponge or shower bath, taken in a comfortable room daily, makes the skin perform its functions better, accustoms it to sudden changes of temperature, and renders one less susceptible to colds. If the reaction is not prompt and complete, the bath should be less cold until tolerance is acquired.

A person who has had or is likely to have tuberculosis should choose an occupation demanding as little heavy physical labor, anxiety, or wearing responsibility as possible, and affording the shortest hours, the most outdoor life, or the best ventilation inside, with sufficient remuneration to provide sanitary quarters and plenty of good food.

APPENDIX III

THE following leaflet, by Dr. George H. Kress, of Los Angeles, Cal., submitted in competition for the best educational leaflet for mothers, was awarded a gold medal at the International Congress on Tuberculosis in 1908:

FACTS A MOTHER SHOULD KNOW CONCERNING TUBERCULOSIS

Tuberculosis a Disease Responsible for Untold Sorrow to Mothers.

Tuberculosis, or consumption, is a disease which robs the mothers of the world of one out of every ten children.

The causes of this disease are known, likewise the means whereby it may be prevented.

Every mother owes it to herself and her family to know about tuberculosis, so that the lives of her children may not be placed in peril.

The Frequency of Tuberculosis.

In the United States more than 150,000 persons die every year from tuberculosis. The great majority of these persons are in the prime of life. Many of these persons are married, and their untimely deaths mean dependent families to be cared for by the State.

The loss in money to the United States from these preventable deaths every year amounts to more than three hundred million dollars. The suffering caused by the disease it is impossible to estimate.

Two Important Facts about Tuberculosis.

Tuberculosis is preventable.

Tuberculosis is curable.

These are most important facts worthy of widest circulation, especially since contrary ideas prevail.

Universal prevention and cure of this disease will result only when there is universal effort against it.

In this work of prevention and cure, the mothers of the world can wield a tremendous influence.

The world counts on the aid of the mothers, for what mother would condemn either her own or any other child to an unnecessary death?

What are the Causes of Tuberculosis?

First, there is an exciting cause, which is a very small plant called a germ. There can be no tuberculosis unless this germ be present in the body.

Second, the person who takes this disease has a body that is favorable to it. Any person whose health and strength is run down is predisposed to tuberculosis, because in such a person there is not much resistance.

The two things necessary, then, for tuberculosis are the presence of a certain germ in the body of a person whose health, for any reason, has been run down.

What the Germ Does in the Lungs.

When the germ gets into the body of a person who is run down in health, it finds a soil suitable for its growth and produces the disease called tuberculosis.

The germs produce little granules called tubercles, which may later become little ulcers or abscesses.

Poisons are also thrown out by the germs and get into the blood, and these poisons cause most of the symptoms of the disease.

What are the Symptoms of Tuberculosis?

The symptoms are different, according to the stage.

It is the symptoms of the early stages that should be learned, for it is then that cure can be brought about and lives saved. What are these symptoms?

The disease usually comes on in very slow and mild fashion. That is what throws the persons infected off their guard. There may be nothing more than a tired feeling, especially after work, a lessened appetite, some loss of weight, and perhaps an occasional cough.

As the disease grows worse, these symptoms do likewise. The loss of weight may be very noticeable; there may be fever and night sweats. With the more frequent cough much sputum may be expectorated.

In the far advanced stages some of these symptoms—like cough, loss of weight, and fever—may be very pronounced. Then we have the picture of the "consumptive."

How May Tuberculosis be Prevented?

Tuberculosis is prevented by doing two things:

1. Killing the germs that cause the disease.

2. Having people become healthy, so that they will not be predisposed to the disease.

How are the Germs to be Destroyed?

The germs are scattered far and wide in the sputum which is coughed up by consumptives. One consumptive can cough up in a single day several billion of these germs.

When this sputum dries as dust the germs are blown about in all directions, to get into the air we breathe and on the food and things we eat and handle. In this way every person at some time in life probably gets the germs into his body.

To destroy these germs, all that is necessary is to destroy the sputum.

If sputum be coughed into paper cups or napkins, these can be burned and the germs destroyed. For spittoons, disinfectant solutions like lye should be used.

Coughing in people's faces or spitting on the streets, and especially on floors, is dangerous.

How May the Predisposition of a Weakened Body be Overcome?

Bodily weakness—that is, the predisposition to tuberculosis—may be overcome by right living, particularly by breathing pure air, eating nourishing food, and getting the proper proportion of rest and exercise.

A child weak at birth should be guarded, and as it grows older made to spend much time out of doors.

Children weak from disease like measles or whooping cough should not be neglected. These and kindred diseases are often responsible for tuberculosis being set up later on in life.

Children should not be made to work at too early an age, nor allowed to study so hard as to interfere with health.

The food should be eaten slowly, and should always be nourishing. If cow's milk is used, it should be obtained, if possible, from a dairy having no tuberculous cattle.

The living and sleeping rooms of the family should always be well ventilated. The human body, if it is to be in a healthy state, must have pure air. Bedrooms should not be overcrowded and single beds are advisable.

The above rules can be taken to heart by grown-up persons as well.

These simple rules are worth observing, because a healthy body is usually able to overcome tuberculosis, but a weakened body is not.

How May Tuberculosis be Cured?

Tuberculosis may be cured by the same measures which prevent it, namely, by making the body stronger so that it will be able to kill the germs that have gotten into the tissues.

The pure air, good food, lots of rest treatment, cures more people of tuberculosis than all the medicines that are known.

Avoid patent medicines for tuberculosis, particularly cough medicines, as these usually contain alcohol and opiates, which, though they may make the patient feel better, usually allow the disease to grow worse.

The above methods should be carried out under the advice of a private or dispensary physician who has made a study of the disease.

"Develop healthy bodies."

APPENDIX IV

AN ACT to provide for reports and registration of all cases of tuberculosis in ———, for the free examination of sputum in suspected cases, and for preventing the spread of tuberculosis in ———:

Be it Enacted, etc. That tuberculosis is hereby declared to be an infectious and communicable disease, dangerous to the public health. It shall be the duty of every physician in ——— to report to the health officer of said ———, in writing, on forms to be provided by said officer, the name, age, sex, color, occupation, and address of every person in said ——— having pulmonary or any other communicable form of tuberculosis, who has been attended by such physician for the first time, within one week after the disease is recognized. It shall also be the duty of the chief officer having charge for the time being of each and every hospital, dispensary, asylum, or other similar public or private institutions in said ——— to report in like manner the name, age, sex, color, occupation, and last address of every patient afflicted with pulmonary or any other communicable form of tuberculosis who is in his care or who has come under his observation, within one week of such time.

SECTION 2.—That the health officer of said ——— shall make, or cause to be made, a microscopical examination of the sputum of persons having symptoms of tuberculosis, which shall be accompanied by a blank giving name, age, sex, color, occupation, and address of the patient whenever it be requested by the attending physician or by the proper officer of any hospital or dispensary; and shall promptly make a report thereof, free of charge, to the physician or officer upon whose application the examination was made.

SEC. 3.—That the health officer of said ——— shall cause all reports made in accordance with the first section, and all reports showing the presence of tubercle bacilli received in accordance with the second section of this act to be recorded in a register, of which he shall be the custodian, and which shall not be open to inspection by anyone outside the health department of said ———; and neither said health officer nor anyone connected with said health department shall permit any such report or record to be divulged in such manner as to disclose the identity of the person to whom it relates, except as it may be necessary in carrying out the provisions of this act.

SEC. 4.—That in case the attending physician fails to request in his report that they shall not be furnished, it shall be the duty of the health

department to supply to each patient, or to those in charge of such patients, printed instructions as to the methods to be employed to prevent the spread of the disease in each case of tuberculosis so reported.

SEC. 5.—That in case of the vacation of any apartments or premises by death from pulmonary or any other communicable form of tuberculosis, or by the removal therefrom of a person or persons so afflicted, it shall be the duty of the attending physician, or, if there be no such physician, or if such physician be absent, of the owner, lessee, tenant, occupant, or other person in charge of said apartments, or premises, to notify the health officer, in writing, of such death or removal, within twenty-four hours thereafter, and such apartments or premises shall then be disinfected by the health department at public expense, or, if the owner prefers, by the owner to the satisfaction of the health department, and shall not again be occupied until so disinfected.

SEC. 6.—That it shall be the duty of every person in attendance upon anyone afflicted therewith, and of the authorities of public and private institutions or dispensaries in said ———, to observe and enforce all sanitary rules and regulations of the health department for preventing the spread of tuberculosis.

SEC. 7.—That upon the recovery of any patient from the tuberculous condition for which he was previously reported a report to that effect to the health department, made by the attending physician, shall be recorded and shall relieve said patient from further liability to any requirements imposed by this act.

SEC. 8.—That any person violating any of the provisions of this act shall, upon conviction thereof, be deemed guilty of a misdemeanor, and shall be punished by a fine not exceeding twenty-five dollars.

SEC. 9.—That all acts and parts of acts contrary to the provisions of this act, or inconsistent therewith, be, and the same are, hereby repealed.

APPENDIX V

INSTRUCTIONS FOR THE PHYSICIAN'S USE IN PRIVATE PRACTICE

COMPILED BY S. A. KNOPF, M.D.

THE leaflet which is presented here I have made use of in my private and consultation practice, and also in my hospital and dispensary work, for a number of years. Reading it to the patient has helped me to impress upon him vital points in the prevention and treatment of the disease, some of which, had I relied on my memory, I am quite sure would often have been forgotten.

Except in hospital or dispensary practice, I do not recommend giving these instructions to a patient in printed form. To have them typewritten will make them seem more as if intended for him individually, even though the special directions may be filled out in writing. The instructions should always be signed by the attending physician.

GENERAL ADVICE

Be hopeful and cheerful, for your disease can be cured.[1]

Avoid anxieties and worry as far as possible.

Do not talk to anyone about your disease or symptoms, except to your physician or nurse.

When indoors remain in the sunniest and best-ventilated room. It is better to have no carpets or heavy hangings in the room; small rugs and washable curtains may be allowed. Cleaning should be done with a moist or slightly oily rag, according to the surface to be gone over.

Never sleep or stay in a hot room. Have your own sleeping room if possible, but always have your own bed, which should be freely aired during the daytime. In cold weather you may have a fire in the room, but keep the window wide enough open not to have the room warmer than 60° to 65° F.

Keep at least one window always open in your bedroom. Night air is as good, and in cities even better, than day air.

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[1] If the condition of the patient demands that it would be more advisable to say "your condition can be improved," this should of course be done.

Have at least nine hours' sleep in the twenty-four, and retire early. If you have to work during the week, and feel as if you do not get a sufficient amount of rest, remain in bed all Sunday morning and get thoroughly rested.

If you are directed to sleep outdoors in a tent, on a veranda, on a porch, or in a window-tent, begin gradually, and in cold weather be particular to dress warmly for the night and have plenty of bed covering. Your feet must be kept warm.

Remain in the sunshine as much as possible, except in very hot weather; but always protect your head. If there is no sheltered spot outdoors or on a veranda, the best place to take a sun bath is in front of the open window. Extend yourself on a comfortable lounge with your head in the shade and the body bathed by the rays of the sun; remain there as long as you feel comfortable.

A feeling of discomfort, headache, or a rise of temperature, are indications that you have been exposed too much to the sun, and that you must seek the advice of the physician before resuming the sun-baths.

Live as much as you can in the open air. Do not be afraid of cold weather; in snowy or rainy weather always wear rubber shoes and an outer garment which will keep you dry and warm. Remain indoors only on very windy and stormy days.

The rest cure in the open air on a reclining chair can and should be taken in all kinds of weather, providing you protect yourself against rain or too strong winds. Whether you are taking your rest cure outdoors during the day, are sleeping outdoors, in a window-tent, or in a room with the windows wide open, if you suffer from the cold, it is time to return to the house or close part of the window. Protect yourself better the next time, for the air does not do you any good when you become chilled.

Dress yourself comfortably, but not so heavily as to hinder your movements. Discard chest protectors, for they only tend to make you take colds more easily. Wear a suit of linen-mesh underwear; but do not change from wool to linen in cold weather unless you begin by wearing the linen mesh next the skin and some warmer undergarment of cotton or wool over it. Keep your feet dry and warm, particularly when you are taking the rest cure in the open air in cold weather. Use a heated soapstone or hot-water bag, if necessary.

Take a bodily and mental rest on a comfortable reclining chair for about thirty minutes before and after the principal meals.

Do not take any kind of medicine (patent or other) or exercise, except such as are prescribed by your physician.

Avoid all unnecessary exertions, mental or physical. Avoid exciting conversation. Never run nor lift heavy weights. Never take any exercise when you are tired, nor exercise to the extent of getting tired. Avoid getting into perspiration.

When walking against the wind, riding in carriage or automobile, do not converse, but keep your mouth closed, and breathe through the nose only.

Take your walking exercises as you have been directed, and, when feasible, begin with walking slowly uphill; the return will then be easier.

Take your breathing exercises regularly as prescribed; always breathe through the nose.

Avoid strong draughts, dust, and dampness, and all places where the air is bad, such as theaters, concert halls, crowded meeting places, etc.

In cold weather bathe and dress in a warm room. If you sleep in a tent, have a fire made before rising; if on a veranda, have your bed rolled into a warm room or go there quickly, covering yourself with a coat or blanket. If you sleep in a window-tent, close the window, and wait until the room is sufficiently warm before dressing. As a rule, in winter do not leave the house until an hour after sunrise, because the air before that time is usually very much colder. By taking these precautions you will avoid being chilled.

Try to control your cough. You should train yourself to cough only when you have to expectorate.

All expectoration—that is to say, spittle—contains germs. Some of these, especially when there is throat, bronchial, or lung trouble, are dangerous. Thus it is best to be careful and gather all the expectoration, of whatever nature, and destroy it before harm can be done by it. To this end one should always expectorate in a proper receptacle, and see to it that its contents are destroyed. Carelessness in this respect is sure to cause the spread of the disease to others. This method of disposing of the sputum also protects the patient himself from taking the same germs into his system again, either by inhaling dust containing particles of the dried sputum, or by infecting himself through sores. Be particularly careful when you have any wound or scratch on your hands, for if tubercuious matter comes in contact with an open wound, local infection or inoculation may take place. It is not safe to use a handkerchief to spit into, since in this way an infection of the nose is possible.

When at home always expectorate in a spittoon filled partially with water, or, better, with water into which you have put one part of carbolic acid to twenty parts of water (five-per-cent solution). When you cannot conveniently get at the stationary cuspidor, use a pocket spittoon. When away from home or if the use of such a pocket flask or spittoon is not practicable, use squares of muslin simulating handkerchiefs or use Japanese paper handkerchiefs to expectorate in. Keep them in a leather pouch or in a pocket lined with impermeable material until you can burn them on your return home. Ladies should divide their handbags into two compartments to serve the same purpose. For people who live in flats where the cooking is done over gas, it may be difficult to find a place to burn the cheap

handkerchiefs, rags, pasteboard pocket spittoons, or paper. While the thin paper might be thrown into the water-closet, this cannot be done with rags or pasteboard. Individuals thus situated should use thin paper which they can throw into the water-closet, or a pocket flask of metal or glass which should be emptied into the closet and cleaned with hot water. There are small and convenient ones that can be hidden in the folds of a handkerchief when used.

All stationary spittoons should be covered, for flies and other insects may crawl over them, partake of the tuberculous matter, and by depositing the latter on articles of food or elsewhere, become propagators of tuberculosis.

Whether sick or well, never expectorate on the sidewalk, but always in the gutter if there is no spittoon convenient.

Never swallow your expectoration. Never use the same handkerchief to wipe your nose which you use to wipe your mouth after having expectorated. Always cover your mouth with a handkerchief or the hand while coughing or sneezing. Never kiss anyone on the mouth nor allow it to be done to you.

Handle the soiled personal and bed linen, especially handkerchiefs, as little as possible in the dry state. When soiled, place these articles in water until ready to be washed.

It is best not to wear any mustache or beard, but if worn, they should be closely clipped.

Always wash your hands thoroughly before touching food.

Directions Concerning Food, Drink, Stimulants, Etc.

Live on a mixed diet—that is to say, meat, fish, oysters, vegetables (especially spinach, lentils, cauliflower); fresh and cooked fruit, particularly grapes, plenty of fresh milk, fresh eggs; all sorts of easily digested fats, especially butter. Thick, nourishing soups should be eaten with the principal meals. Raw, chopped, or scraped beef is especially to be recommended. Whole-wheat bread, being more nourishing than white bread, is to be preferred. Do not eat the inside of fresh bread; bread with a hard crust, toast, and stale bread are more easily digested and more nourishing.

Eat slowly, chew your food well, take the milk in small swallows; take but little liquid during and shortly after meals. Keep your teeth in good condition; use toothpick and brush after each meal.

Never take any alcoholic beverages (wine, beer, or liquor) without special consent and direction of your physician. Too much sweets (sugar, pies, pastry, etc.) should also be avoided, as well as all kinds of fried food.

Drink plenty of good pure water between mealtimes (not with meals).

Do not use tobacco in any form; smoking cigarettes and inhaling the smoke is particularly injurious.

Special Diet

Directions Concerning Baths and the Use of Cold Water

Take a short, warm bath once a week, followed by a rapid sponging with cooler water and a vigorous rubbing with a rough towel.
Wash your neck and chest every morning with cold water.

Special Directions for the Use of Cold Water

Special Directions for Breathing Exercises

Take exercise No. Repeat times, every hour. These exercises are to be taken near the open window or outdoors.

Special Directions for Walking, Riding, and Other Exercises

Special Medical Advice

Special Advice for the Patient, Nurse, and Family

Any intercurrent trouble such as fever, indigestion, diarrhea, constipation, increased cough, pain, reddish expectoration, or hemorrhage, should be at once reported to the physician. Do not, however, be alarmed if a hemorrhage occurs, as it is but one of the phases of the disease and does not lessen the chances for recovery. Let the patient remain quiet on a reclining chair or on the bed, and, until the arrival of the physician, place a cold compress or ice bag over the heart. In case of fever, particularly when it is as high as 100° F. or more, it is best for the patient to go to bed and await instructions from the physician.

A careful and obedient patient has all possible chances of getting well, while he who is careless and disobedient may forfeit all possibility of recovery.

To All Whom it May Concern:

The careful, clean, and conscientious consumptive, who is trained in the prevention of the disease, is not dangerous to those with whom he may live and work.

———, M.D.,
Attending Physician.

APPENDIX VI

FORMULARY FOR THE SYMPTOMATIC TREATMENT OF PULMONARY AND LARYNGEAL TUBERCULOSIS

COMPILED BY S. A. KNOPF, M.D.

The following formulary is that principally used in the Clinic for Pulmonary Diseases of the New York Health Department, with which I have the honor to be associated. This compilation of prescriptions was arranged for the following reasons: Shortly after the inauguration of our clinic, I found that among the twelve physicians comprising the attending staff, while there was almost a unanimity concerning principal drugs which might be of value in the symptomatic treatment of pulmonary tuberculosis, there was no unanimity as to the best method to combine or administer them. There was also a slight tendency among some of the staff to write too many prescriptions. All of the attending physicians were men experienced in general practice, and a number of them had had special training in tuberculosis. To limit the number of prescriptions, to simplify their composition, and to select those which in the experience of my staff and myself had proven of real value, we came together and discussed the matter at length. We proceeded as follows: Each one, for example, proposed his favorite remedy for cough, and after he had defended his reason for the preference of his remedy, I ventured to propose my own favorite prescriptions, and gave my reasons for their preference. We then decided by vote which to accept. There was never a heated dispute about any drug or prescription, but only careful and deliberate discussion, and when we decided on any particular recipe it was always on a unanimous vote. This formulary has now been in use for a number of years, and it would seem that it has proved quite satisfactory to physicians and patients. I have made a few changes and added a few other prescriptions which have proved of value in private practice.

In addition to this, I wish to say that most of these prescriptions I have also used in my service in the Riverside Sanatorium for Pulmonary Diseases of the New York Health Department, where the majority of patients received are in the advanced stages. It has been found to be of great economy, by our department, to have the majority of these

drugs put up by the department's pharmacist. The prescribing and filling of the dispensary physicians' prescriptions according to number is, of course, a great saving of time.

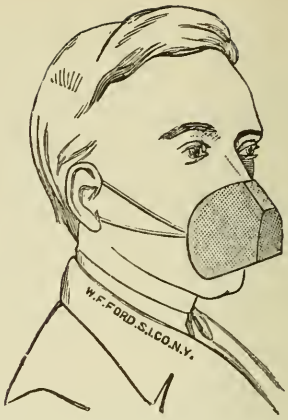


Fig. 5.—Beverley Robinson's Zinc Inhaler.

TO COMBAT COUGH

Inhalation

℞ Olei eucalypti,
Spirit. chloroformi,
Menthol, } āā.... ℥ijss.

M. Sig.: Inhale five to fifteen drops with aid of inhaler or handkerchief three to four times daily for several minutes at a time.

℞ Creosoti (beechwood),
Spirit. chloroformi,
Spirit. rectif., } āā ..... ℥ijss.

M. Sig.: Inhale ten to fifteen drops with aid of inhaler or handkerchief three to four times daily for several minutes at a time.

℞ Menthol ..... gr. v;
Creosoti ..... gtt. v;
Olei olivæ .....fl ℥j.

M. Sig.: Warm and inject one drachm into larynx daily with the aid of intratracheal syringe.

Cough Mixtures

℞ Mist. glycyrrhizæ compos..... ℥vj.

Sig.: One half to one tablespoonful every two to three hours.

℞ Heroinæ hydrochlor. ..... gr. ij;
Acid. sulphuric. dil..... ♏xlv;
Glycerinæ ..... ℥j;
Aq. laurocerasi,
Syrup. pruni virg., } āā..... ℥iv;
Aquæ destillatæ.....q. s. ad. ℥iij.

M. Sig.: One teaspoonful three or four times a day.

℞ Codeinæ ..... gr. iij;
Acid. sulphuric. dil..... ♏xlv;
Glycerinæ ..... ℥j;
Aq. laurocerasi,
Syrup. pruni virg., } āā..... ℥iv;
Aquæ destillatæ.....q. s. ad. ℥iij.

M. Sig.: One teaspoonful three or four times a day.

℞ Elixir terpini hydrat. ..... ℥j;
Glycerinæ ..... ℥iv;
Syrup. pruni virgin..... ℥jss.
M. Sig.: One teaspoonful every three to five hours.

Stokes's Expectorant

℞ Ammon. carbonat. ..... gr. xvj;
Extr. fluid. senegæ. } āā..... ℥ss;
Extr. fluid. scillæ, }
Tinct. opii camphorat..... ℥iij;
Syrup. tolutani.....q. s. ad. ℥ij.
M. Sig.: A teaspoonful every two to four hours as needed to relieve distressing and suffocating cough.

For Cough when there is at the Same Time Dyspneic or Asthmatic Difficulty

℞ Ammon. brom.. } āā..... ℥j;
Ammon. chlor., }
Tinct. lobeliæ ..... ℥j;
Spirit. ether. co..... ℥ss;
Syrup. acaciæ.....q. s. ad. ℥iij.
M. Sig.: One teaspoonful every three to four hours.

ANODYNES

For Acute Pleuritic Pains with Fever

℞ Heroinæ,
No. XII in tablet form, } āā..... gr. $\frac{1}{12}$.
Sig.: One tablet three or four times a day.

℞ Morphinæ sulphat.,
No. IV in tablet form, } āā..... gr. $\frac{1}{8}$.
Sig.: One at bedtime.

℞ Tinct. aconit. rad., } āā..... ℥j.
Tinct. opii deodorat., }
M. Sig.: Five drops in water every hour or two.
Note.—For pleuritic pain.

For Local Use

℞ Tincturæ iodi.
Sig.: Use externally with a brush, as directed.

℞ Linimenti chloroformii.

Sig.: Rub over painful parts, as directed.

℞ Emplastri sinapis,
No. 1.

Sig.: Apply as directed.

℞ Zinc-oxid adhesive plaster (for strapping in acute pleurisy).

TO COMBAT HYPERIDROSIS (*Night Sweats*)

℞ Atropinæ sulphat.,
No. VI in tablet form, } āā..... gr. $\frac{1}{100}$.

Sig.: One tablet at bedtime.

℞ Pulv. agarici ..... ʒj.
In pulv. No. XII div.

Sig.: One powder every two hours (for three doses), if necessary.

℞ Pyramidon camphorat. (neutral)..... ʒj.
Div. in chart. No. VIII.

Sig.: One at bedtime.

TO COMBAT HEMOPTYSIS

℞ Stypticin ..... gr. ij;
Plumbi acetas ..... gr. xviij;
Pulv. digitalis ..... gr. ix;
Pulv. opii ..... gr. v.

M. Ft. capsulas No. 9. Sig.: One every four hours.

℞ Acid. gallici ..... ʒij;
Acid. sulph. aromat..... ʒj;
Glycerinæ ..... ʒj;
Aquæ.....q. s. ad. ℥vj.

M. Sig.: One teaspoonful every hour or two, as needed.

TO COMBAT HEART COMPLICATIONS

℞ Tinct. digitalis ..... ♏xxx;
Aquæ destillatæ.....q. s. ad. ʒij.

M. Sig.: One teaspoonful three or four times a day.

Note.—For weak and irregular heart.

For Tendency to Heart Failure

℞ Caffeinæ citratæ ..... gr. ix;
Acetanilidi ..... gr. vj;
Sodii bicarbonat. ..... ʒjss.
Div. in capsulas No. IX.

Sig.: One capsule every three to four hours, as required.

℞ Sodii bromidi ..... ʒij;
Chlorali hyd. ..... gr. xl;
Aquæ destillatæ.....q. s. ad. ʒij.

M. Sig.: One teaspoonful in a little water three times a day.

Note.—For extra high tension pulse, one dose at bedtime.

TO COMBAT CONSTIPATION

℞ Hydrarg. chlor. mite, No. XII in tablet form, } āā..... gr. ¼.

Sig.: One every hour until free movement is produced.

Note.—For occasional constipation.

℞ Olei ricini ..... ℥ss.

Sig.: Take as directed.

Note.—For occasional constipation.

℞ Pluto concentrated spring water.

Sig.: Two to four tablespoonfuls, diluted in cold water, upon rising.

℞ Sodii salicylatis ..... ʒij;
Sodii phosph. ..... ʒv;
Potass. sulph. .....ad. ʒij;
Pulv. zingiberis ..... ʒj.

M. Sig.: A teaspoonful in hot water, early in the morning.

Pil. Lapacticæ

℞ Aloin ..... gr. ¼;
Strychninæ ..... gr. $\frac{1}{60}$;
Extr. belladonnæ ..... gr. ⅛;
Ipecacuanhæ ..... gr. $\frac{1}{16}$.

Sig.: One to two pills at bedtime.

℞ Ext. cascaræ sagrad. fld.,
Elixir simplicis, } āā..... ℥j.

Sig.: Two teaspoonfuls at bedtime.

Note.—The three preceding remedies should be given alternately in chronic constipation, and aided by appropriate diet.

TO COMBAT DIARRHEA

℞ Pulv. opii ..... gr. iij;
Bismuth. subnitrat ..... ℥jss;
Sod. bicarbonat ..... gr. xlv.

M. Div. in chart. No. IX. Sig.: One capsule three or four times a day.

Note.—For ordinary diarrhea (due to dietetic errors) after having evacuated intestinal tract.

℞ Pulv. opii ..... gr. vj;
Acid. tannici ..... ℥j.

M. Div. in chart. No. XII.

Note.—For chronic diarrhea, seemingly due to tuberculous invasion of the intestinal tract.

TO COMBAT OTHER DIGESTIVE DISTURBANCES

℞ Phenyl. salicylat. ..... gr. xxiv.
Div. in capsulas No. XII.

Sig.: Take one capsule one half hour before each meal.

℞ Liquor. pepsini ..... ℥viij.

Sig. One to two teaspoonfuls after each meal.

℞ Pilularum creosoti,
(Enteric coated) No. XVIII, } āā..... gr. ij.

Sig.: One three times a day after meals.

℞ Peptenzyme,
Sodii bicarbonat.,
Pulvis aromatici, } āā..... ℥iv;
Pulvis rhei ..... ℥j.
Ft. pulvem et div. in caps. No. XXIV.

Sig.: One after each meal.

TO COMBAT ANOREXIA AND EMACIATION

Tonics

℞ Tinct. nucis vomicæ ..... ℥ij;
Tinct. cinchonæ, } āā ..... ℥j;
Tinct. colombæ, }
Tinct. gentianæ ..... q. s. ad. ℥iv.

M. Sig.: One teaspoonful in three tablespoonfuls of water before meals.

℞ Misturæ rhei et sodii ..... ℥vj.

Sig.: Two teaspoonfuls after meals.

℞ Tinct. nucis vomicæ ..... ℥ij;
Ext. fl. cascaræ sagrad.
Mist. rhei et sodii ..... ℥iv.

M. Sig.: Two teaspoonfuls after principal meals.

Note.—For anorexia with constipation.

℞ Liquor. potassii arsenitis ..... ℥ijss;
Aquæ destillatæ ..... ℥vss.

M. Sig.: Nine drops in one tablespoonful of water after each meal for one week; increase to twelve drops the second week and fifteen drops the third week. Then recommence with nine drops and increase as before.

TO COMBAT ANEMIA

℞ Ovoferrin ..... ℥vj.

Sig.: Two teaspoonfuls, before principal meals, in wineglassful of water.

℞ Syrupi ferri iodidi ..... ℥ij;
Syrupi zingiberis ..... ℥j;
Aquæ destillatæ ..... q. s. ad. ℥vj.

Sig.: A tablespoonful three times a day.

℞ Pil. ferri carbonatis (Blaud's pills) No. XXIV.

Sig.: Two pills after each of the principal meals.

Alteratives

℞ Iodoformi ..... gr. xx;
Strychninæ sulphat. ..... gr. ½;
Ichthyol ..... ℥j.

M. Div. in caps. No. XX. Sig.: One capsule after each of the three principal meals.

℞ Calcii carbonat., } āā 3iij;
Calcii phosphat., }
Sodii chloridi ..... 3ij.

M. Div. in chart. No. XXX. Sig.: To be taken in wafers after principal meals.

Note.—Indicated when there is intense demineralization of the system and formation of cavities. The withholding of all acids while these powders are given will add to their efficiency.

℞ Solut. potassii iodidi (saturated) ..... 3ij.

Sig.: Five drops or more three times daily, as directed.

Note.—Indicated when a syphilitic condition seems to have been added to a tuberculous infection, or *vice versa.*

Nutritives

℞ Iron-tropon ..... 3vj.

Sig.: One to two teaspoonfuls three or four times a day, in milk or water.

℞ Maltine with hypophosphites ..... 3viij.

Sig.: Two to four teaspoonfuls after meals.

℞ Maltine with cod-liver oil ..... 3viij.

Sig.: Two to four teaspoonfuls after meals.

The Maltine preparations are equally good.

℞ Emulsionis sevi et olei comp ..... 3viij.

Sig.: One half tablespoonful three times daily.

TO COMBAT FEVER

℞ Pil. quininæ sulphat., } āā ..... gr. ij.
No. XII, sugar coated, }

Sig.: Take as directed.

Note.—In addition when rest, aero-, and hydro-therapeutic means do not suffice.

TO COMBAT INSOMNIA

℞ Chloral. hydratis 3iij;
Syrupi tolutani 3j;
Aquæ destillat. .....q. s. ad. 3iv.

M. Sig.: A tablespoonful at bedtime.

Note.—Should only be resorted to when the insomnia is due to a purely nervous condition, and aero-, hydro-, and hygienic means have failed.

℞ Veronal ..... 5j.
Div. in chart. No. XII.

Sig.: One on retiring; if necessary, another two hours later.

FOR THE TREATMENT OF LARYNGEAL TUBERCULOSIS AND COMPLICATIONS

Local Remedies

℞ Ichthyol,
Ung. hydrarg., } āā 5ij;
Ung. belladon.,
Ung. petrol ..... 5j.

M. Sig.: Apply freely twice daily.

Note.—For glandular enlargement.

℞ Acidi boric. 5j;
Glycerinæ acidi tannici 5ss;
Olei gaultheriæ ..... ♏x;
Aq. destillat. .....q. s. ad. 5iv.

M. Sig.: To be used in atomizer after cleaning.

℞ Menthol ..... gr. xx;
Camphoræ ..... gr. vj;
Albolene .....q. s. ad. 5j.

Sig.: To be used in oil atomizer after cleaning nose.

℞ Menthol ..... gr. xxv;
Ol. olivæ .....q. s. ad. 5j.

Sig.: For injection or atomizing into larynx.

℞ Sodii chlorid. 5ij;
Sodii bicarbonat. ..... 5iv.

M. Sig.: Dissolve small teaspoonful in pint of warm water and use for cleaning throat.

℞ Seiler's tablets.

Sig.: As directed.

℞ Potassii permanganat. ..... gr. ij.
No. XXIV in tablet form.

Sig.: As directed.

For Internal Use

℞ Cocainæ hydrochloridi ..... gr. ij;
Morphinæ sulphatis ..... gr. iv;
Orthoform. ..... gr. lxxx.

M. Ft. tablets No. XVI. Sig.: Dissolve one in mouth slowly, about fifteen minutes before eating; used in odynphagia of laryngeal ulcers.

℞ Tinct. ferri chlor. ..... ♏xxx;
Hydrargyri chlor. corros. ..... gr. $\frac{1}{10}$;
Tinct. aconiti ..... ♏xx;
Sacchari lactis.....q. s. ad. tabl. No. X.

M. Sig.: Take one and have it dissolve on tongue.

Note.—For acute inflammation of tonsils and pharynx.

℞ Tincturæ ferri chloridi ..... ℥ijss;
Potassii chlorat. ..... ℥ss;
Glycerinæ ..... ℥j;
Aquæ destillatæ.....q. s. ad. ℥iv.

M. Sig.: Take one teaspoonful in tablespoonful of water every three or four hours.

Note.—For acute inflammation of tonsils and pharynx.

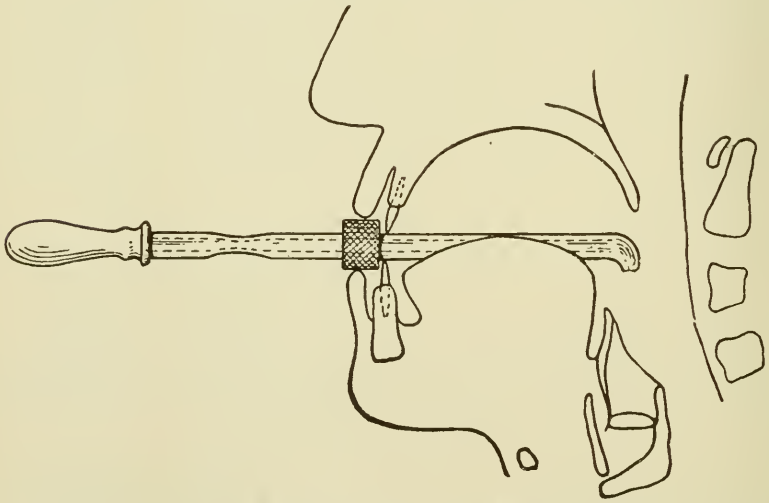


Fig. 6.—A Laryngeal Medicator, Devised by Mannheimer and Yankauer. Can be used for watery and oily solutions. Indicated particularly for dispensary and private practice, when patients cannot be kept under constant medical supervision. Those suffering from painful laryngeal tuberculosis can anesthetize their own larynx, especially before eating. Of medicaments orthoform by itself or mixed with iodoform in equal proportions (emulsified in a yolk of egg) are recommended. (From Knopf and Huey, "Notes on Laryngeal Tuberculosis.")

The following are four standard disinfectants which are simple, cheap, and reliable. They are highly recommended in the circular issued by the Illinois State Board of Health on the subject, "The Cause and Prevention of Consumption":

Standard Disinfectant No. 1

Four-Per-Cent Solution of Chlorid of Lime

Dissolve chlorid of lime of the best quality in water, in proportions of six ounces of lime to one gallon of water.

This is one of the strongest disinfectants known. Discharges from the bowels of a patient suffering from a contagious or infectious disease should be received in a vessel containing this solution, and allowed to stand for an hour or more before being thrown into the vault or water-closet. Discharges from the throat or lungs should be received in a vessel containing this solution.

Chlorid of lime in powder may be used freely in privy vaults, cess-pools, drains, sinks, etc.

Instead of the solution of chlorid of lime, carbolic acid may be used for the same purposes, in a strength of 6½ ounces to the gallon of water. This makes a five-per-cent solution of carbolic acid.

Standard Disinfectant No. 2

Bichlorid of Mercury (1–500)

Dissolve corrosive sublimate and muriate of ammonia in water, in the proportion of two drachms (120 grains—¼ ounce) of each to the gallon of water. Dissolve in a wooden tub, barrel, or pail, or an earthen crock.

Use for the same purpose and in the same way as No. 1. Equally effective but slower in action, so that it is necessary to let the mixture (disinfectant and infected material) stand for about four hours before disposing of it. This solution is odorless, while chlorid-of-lime solution is often objectionable in the sick room on account of its smell.

Standard Disinfectant No. 3

Bichlorid of Mercury (1–1,000)

Dissolve one drachm (60 grains—⅛ ounce) each of corrosive sublimate and muriate of ammonia in one gallon of water. Dissolve in a wooden tub, barrel, or pail, or earthen crock.

Use for the disinfection of soiled underclothing, bed linen, etc. Immerse the articles for four hours, then wring them out and boil them. This solution is excellent for wetting the floors of offices, stores, workshops, halls, and school rooms, before sweeping.

Mixed with an equal quantity of water this solution is useful for washing the hands and general surfaces of the bodies of attendants.

Chlorid of lime, carbolic acid, and corrosive sublimate are deadly poisons.

Standard Disinfectant No. 4

Milk of Lime (Quick-lime)

Slake a quart of freshly burnt lime (in small pieces) with three fourths of a quart of water—or, to be exact, 60 parts of water by weight with 100 of lime. A dry powder of slaked lime (hydrate of lime) results. Make milk of lime not long before it is to be used by mixing one part of this dry hydrate of lime with eight parts (by weight) of water.

Air-slaked lime is worthless. The dry hydrate may be preserved some time if it is inclosed in an air-tight container. Milk of lime should be freshly prepared, but may be kept a few days if it is closely stoppered.

Quick-lime is one of the cheapest of disinfectants. The solution can take the place of chlorid of lime, if desired. It should be used freely in quantity equal in amount to the material to be disinfected. It can be used to whitewash exposed surfaces, to disinfect excreta in the sick room or on the surface of the ground, in sinks, drains, stagnant pools, etc.

In addition I desire to describe the manner in which our New York City Health Department makes use of formaldehyd gas to disinfect rooms and wards which have been occupied by tuberculous patients:

To liberate the formaldehyd gas, take to every pound of lime eight ounces of a mixture (formaldehyd, forty-per-cent solution, two parts, and aluminum sulphate, saturated solution, one part) of formaldehyd, and aluminum sulphate is added. The amount of formaldehyd solution used by the department is one ounce for every 100 cubic feet of space. It is necessary that the formaldehyd be forty-per-cent solution, and that the lime be absolute quick-lime, if good results are to be obtained. If the lime appears streaked with red after addition of the formaldehyd, it indicates that a good part of the formaldehyd has been lost by polymerization.

Preliminary to the liberation of the gas it is advisable to prepare the room and articles to be disinfected in the manner recommended by Novy and Waite, which is as follows:

1. All cracks or openings in the plaster or in the floor, or about the door or windows, should be calked tight with cotton or with strips of cloth. 2. The linen, quilts, blankets, carpets, etc., should be stretched out on a line in order to expose as much surface to the disinfectant as possible. They should not be thrown into a heap. Books should be suspended by their covers, so that the pages will fall open and be freely exposed. 3.

The walls and the floor of the room, and the articles contained in it, should be thoroughly sprayed with water. If masses of matter or sputum are dried down on the floor, they should be soaked with water and loosened. No vessel of water should, however, be allowed to remain in the room. 4. One hundred and fifty cubic centimeters (five ounces) of the commercial forty-per-cent solution of formalin for each one thousand cubic feet of space should be placed in the distilling apparatus and be distilled as rapidly as possible. The keyhole and spaces about the door should then be packed with cotton or cloth. 5. The room thus treated should remain closed at least ten hours. If there is much leakage of gas into the surrounding rooms, a second or third distillation of formaldehyd should be made at intervals of two or three hours.

APPENDIX VII

DEVICES FOR THE PREVENTION OF TUBERCULOSIS

By S. A. KNOPF, M.D.

The following illustrations of various devices for the prevention and treatment of tuberculosis have proved most useful in my experience. I do not, however, wish to say that there are not any number of any other kinds of sputum receptacles which are good, or devices for the rest cure in the open air, tents and tent houses, as practical and as useful as those here illustrated. There is an overwhelmingly large amount of such devices at the disposal of those interested in the problem, and to illustrate and describe them all would take much more than the space reserved for such purposes in a book of this kind.

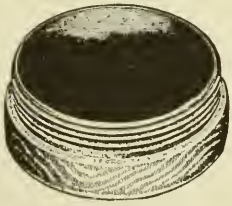


Fig. 7.

Fig. 8.

Figs. 7 and 8.—Improved Wooden Box for Sending Specimens of Sputum to the Laboratory for Examination. (Dr. Hart.)

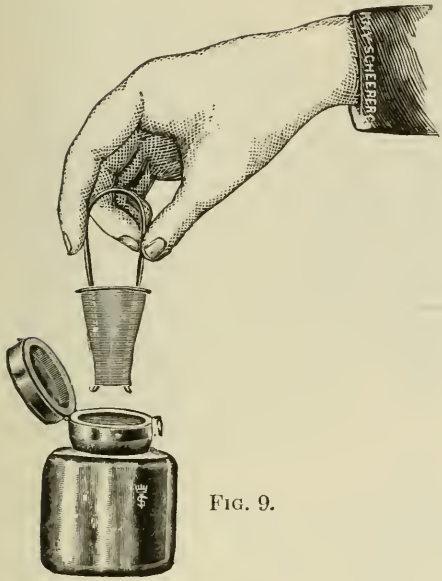


FIG. 9.

FIG. 10.

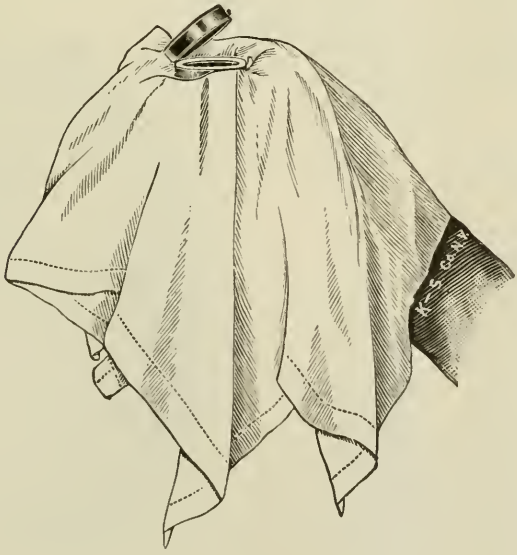


FIG. 11.

FIGS. 9 to 11.—KNOPF'S POCKET FLASK, MANAGEABLE WITH ONE HAND, SHOWING METHOD OF USE.

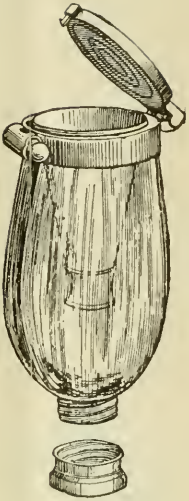


Fig. 12.

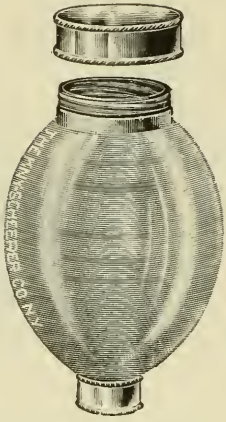


Fig. 13.

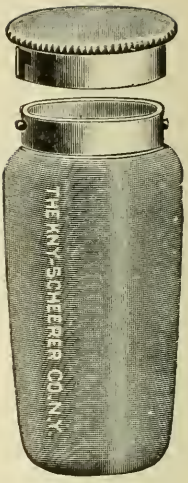


Fig. 14.

Fig. 15.

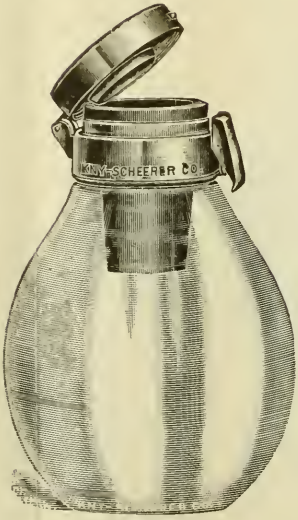


Fig. 16.

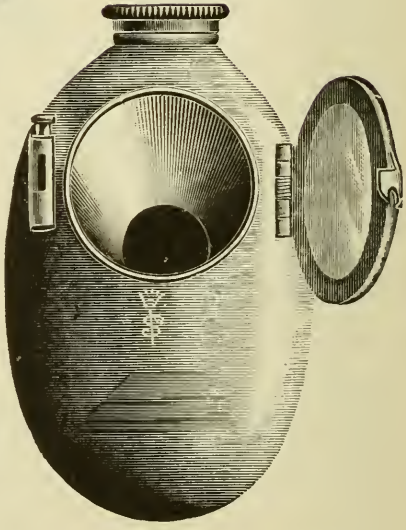


Fig. 17.

Figs. 12 to 17.—Pocket Sputum Flasks. (12) Dettweiler's. (13) With screw cap top and bottom. (14) Knopf's. (15) Liebe's. (16) With spring top. (17) With spring side opening and screw top for emptying.

Fig. 18.

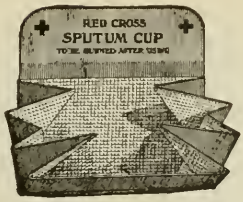


Fig. 19.

Fig. 20.

Figs. 18 to 20.—Three Different Kinds of Paper Pocket Cuspidors. They are destroyed after use.

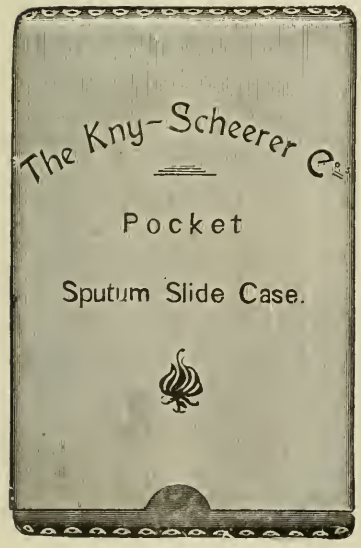


Fig. 21.—Pocket Sputum Case of Paper.

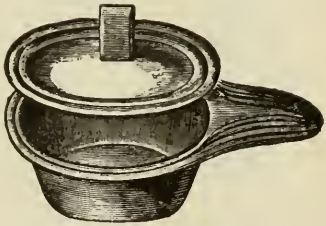


Fig. 22.—Pasteboard Sputum Cup for Bedside. (Kny-Scheerer.)

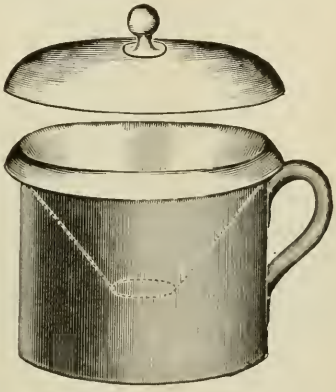


Fig. 23.—Aluminum or Porcelain Spit Cup for Bedside.

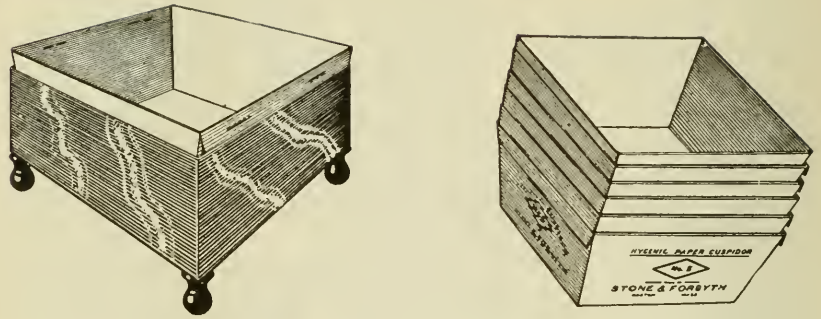


Fig. 24.—Large Hygienic Pasteboard Cuspidor for use in Factories, Public Buildings, etc.

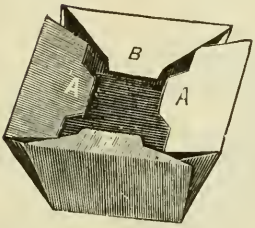


Fig. 25.

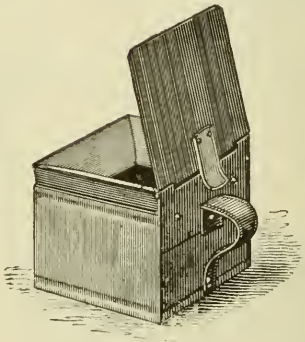


Fig. 26.

Figs. 25 and 26.—Pasteboard Filler and Tin Frame Holder of an Individual Cuspidor (Portable).

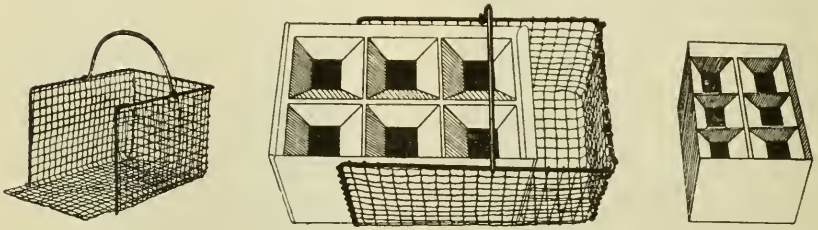


Fig. 27.—Crematory Basket and Fillers. For sanatoria or public buildings.

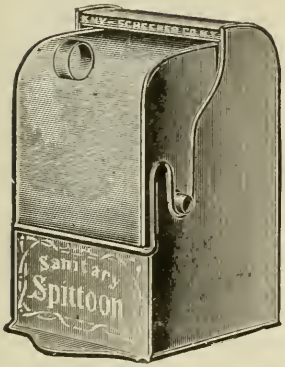


Fig. 28.

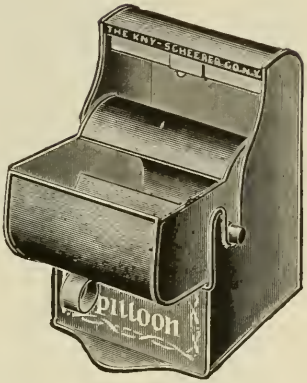


Fig. 29.

Fig. 30

Fig. 28 to 30.—Sanitary Cuspidors to be Attached to Wall, Closed, Open and in Use.

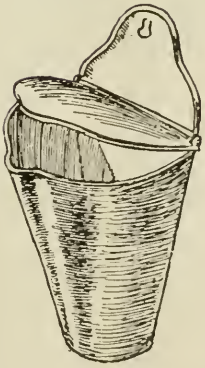


Fig. 31.—Wall Cuspidor. (Predöhl.)

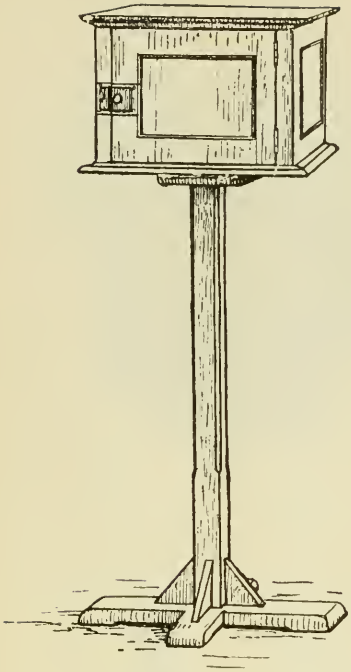


FIG. 32.

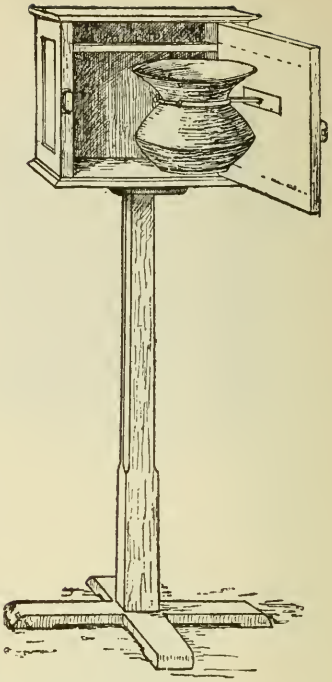


FIG. 33.

FIG. 34.

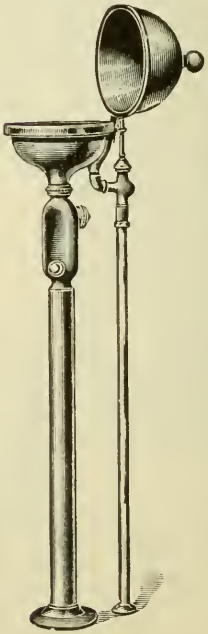


FIG. 35.

Fig. 36.

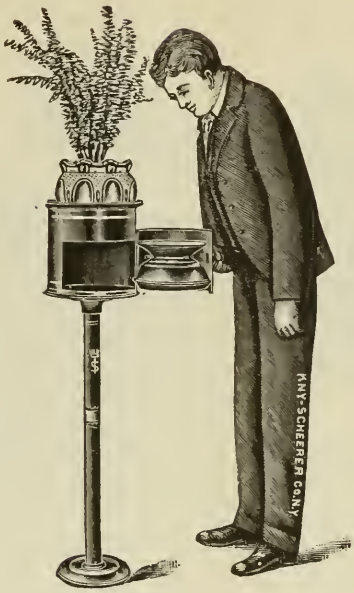


Fig. 37.

Figs. 32 to 37.—Elevated Cuspidors for use in Sanatoria or Public Buildings. (Designed by S. A. Knopf.) (34) With waste and flushing arrangement for use on streets. (35) Similar with cover.

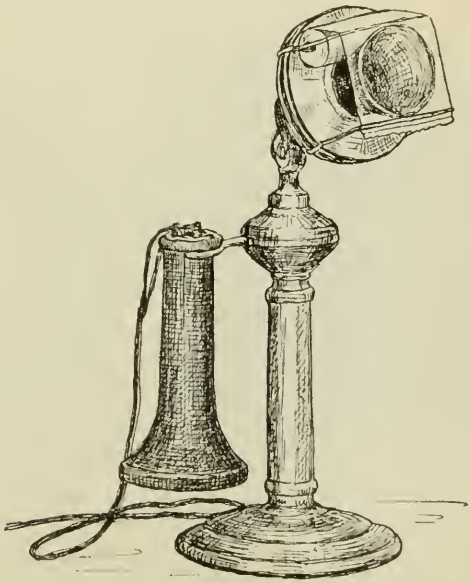


Fig. 38.—Telephone Fitted with Paper Screen to Prevent Infection. (Recommended by S. A. Knopf.)

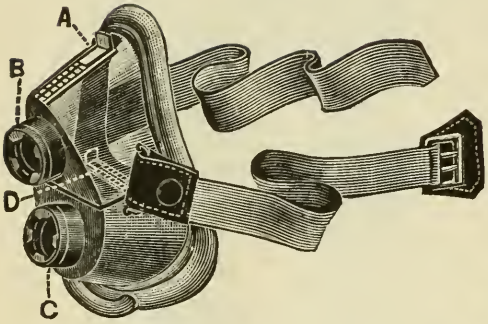


FIG. 39.—SUCTION MASK FOR THE TREATMENT OF PULMONARY TUBERCULOSIS BY HYPEREMIA. (E. Kuhn.) Obstruction of inspiration with free expiration. (*A*) Adjustable nasal opening for inspiration. (*B*) Valve in nasal chamber for expiration. (*C*) Valve in oral chamber for expiration, can be taken off to allow free expiration in case inspiration is made through nose. (*D*) Partition between nasal and oral chamber with adjustable opening to be used when nasal respiration is not practicable.

FIG. 40.—SUCTION MASK ADJUSTED TO FACE. (From Knopf and Huey, "Notes on Laryngeal Tuberculosis.")

FIG. 41.—HUMIDIFIER FOR HOT-AIR REGISTERS.

FIG. 42.—HAIR HYGROMETER REGISTERING DIRECTLY RELATIVE HUMIDITY.

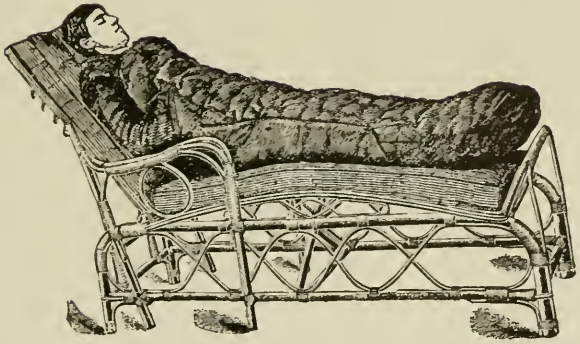


FIG. 43.—RECLINING CHAIR OF BAMBOO WITH PATIENT IN SLEEPING SACK.

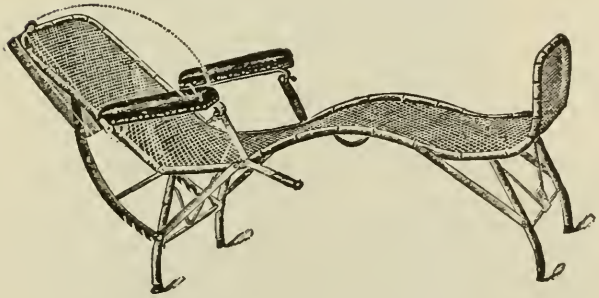


FIG. 44.—RECLINING CHAIR OF STEEL TUBING.

Fig. 45.

Fig. 46.

Fig. 47.

Figs. 45 to 47.—Portable Cot, Occupying Little Space when Folded. (Dr. Weicker.)

FIG. 48.—REST CURE AT HOME, IN A WICKER CHAIR, PADDED ON THE INSIDE.

FIG. 49.—HALF-TENT WITH PATIENT RESTING ON METAL RECLINING CHAIR TAKING THE REST CURE. (S. A. KNOPF.)

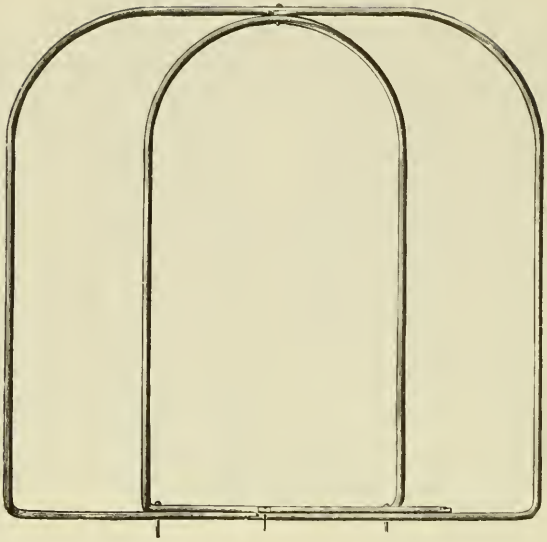


FIG. 50.—STEEL FRAME FOR HALF-TENT FOLDED TOGETHER. (S. A. Knopf.)

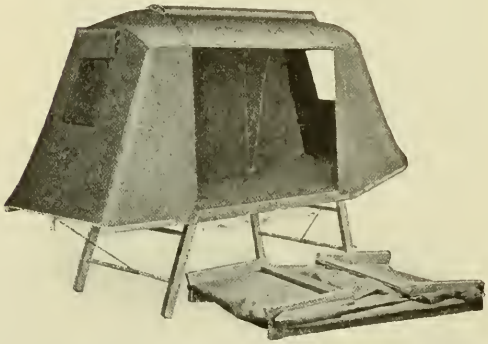


FIG. 51.—PORTABLE TENT COT, OPENED AND FOLDED.

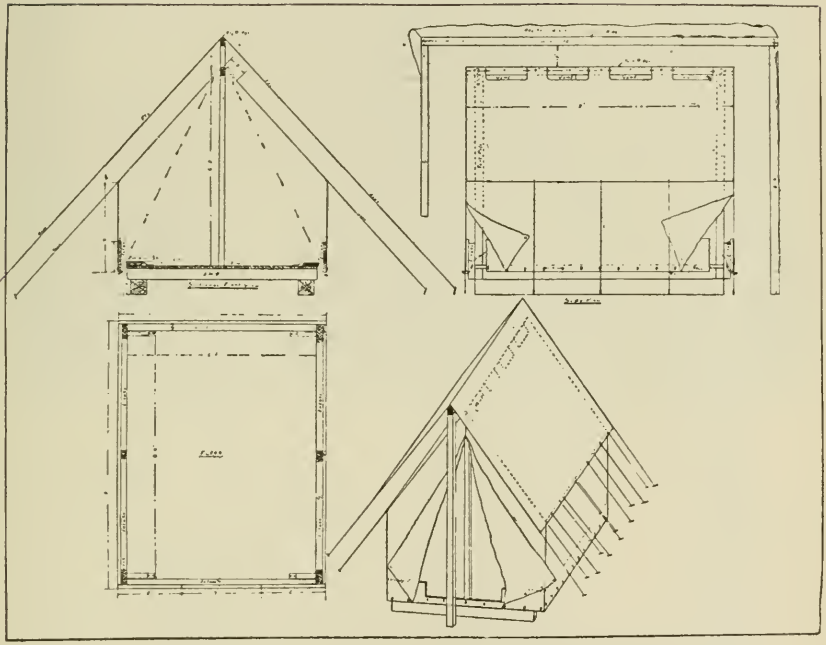


FIG. 52.—A SIMPLE INEXPENSIVE TENT FOR TUBERCULOUS PATIENTS. (Dr. H. L. Ulrich.)

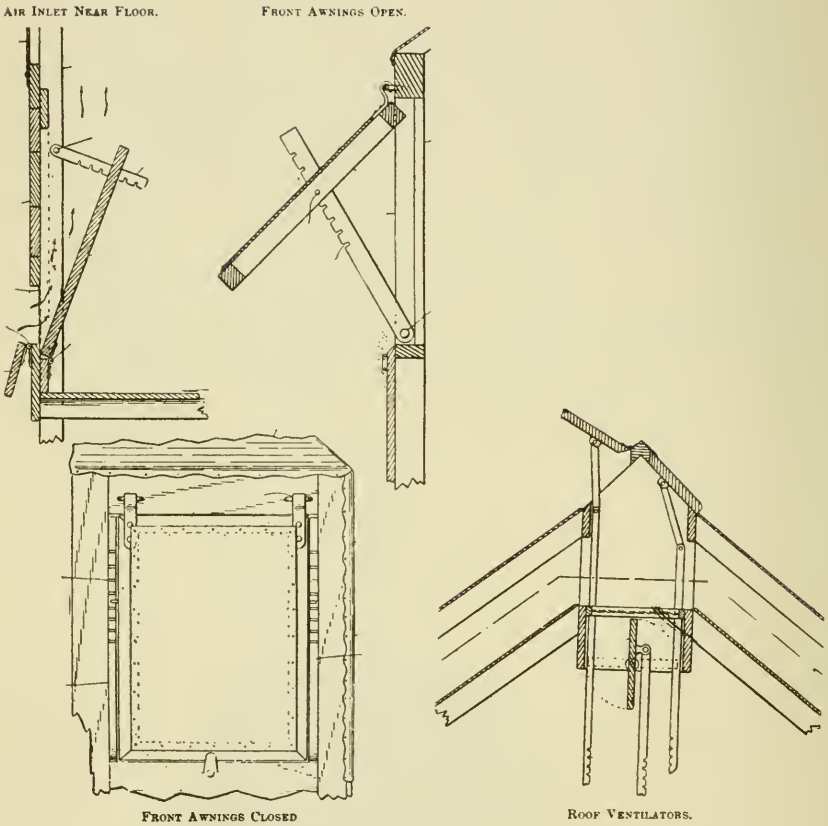


Fig. 53.—Various Ventilating Devices of a Tent. (Tucker.)

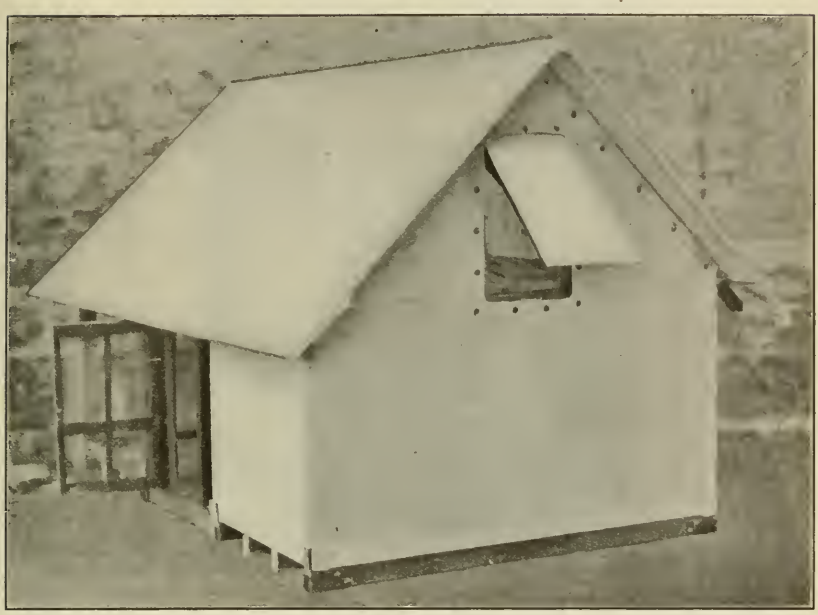


FIG. 54.—PORTABLE COTTAGE. (Walker.)

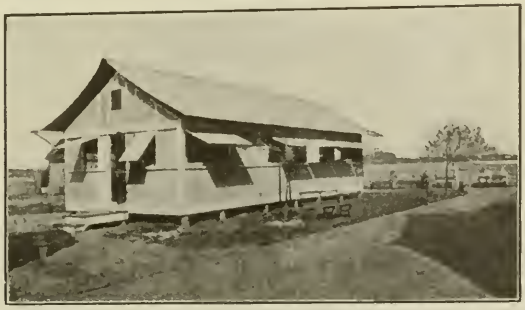
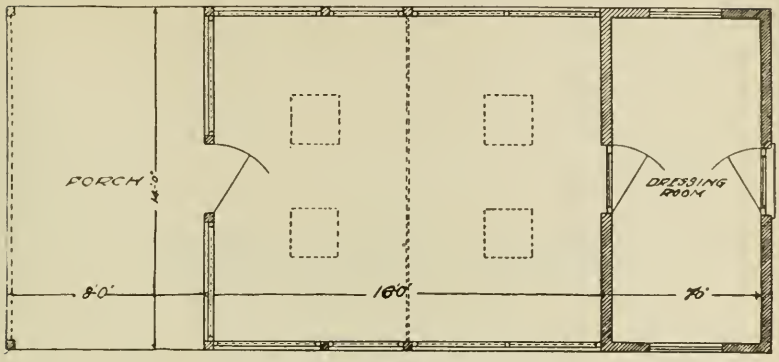


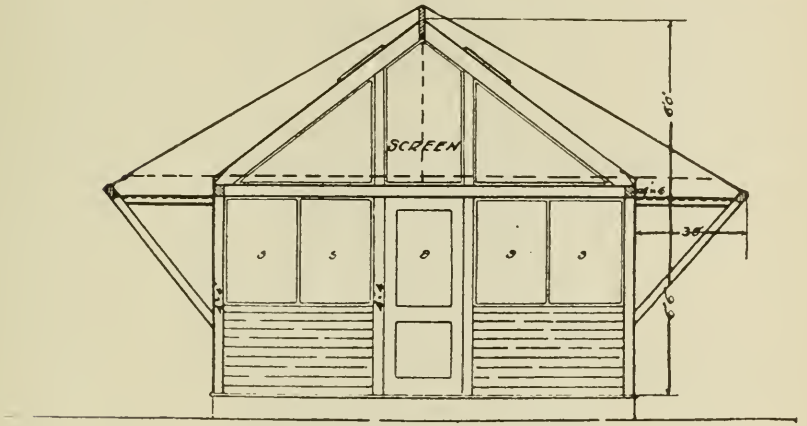
FIG. 55.—TENT ON GROUNDS OF BELLEVUE HOSPITAL, NEW YORK.

FIG. 56.—IRVING FISHER'S TENT.

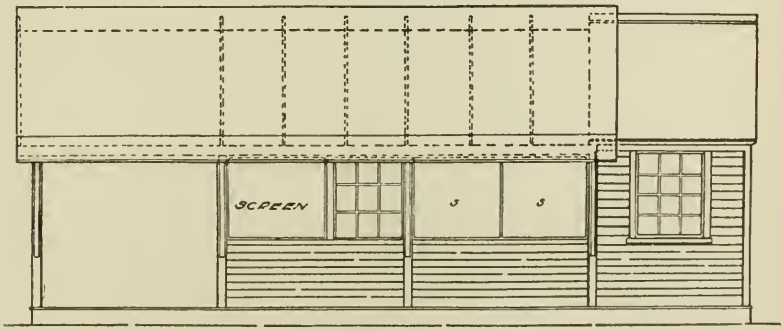
FIG. 57.—DR. BIGGS'S ADIRONDACK TENT HOUSE; IT CAN BE USED WITH PERFECT COMFORT DURING EIGHT OR NINE MONTHS OF THE YEAR.



a



b



c

FIG. 58.—*a*, *b*, *c*. ELEVATIONS AND FLOOR PLAN OF DR. BIGGS'S ADIRONDACK TENT HOUSE.

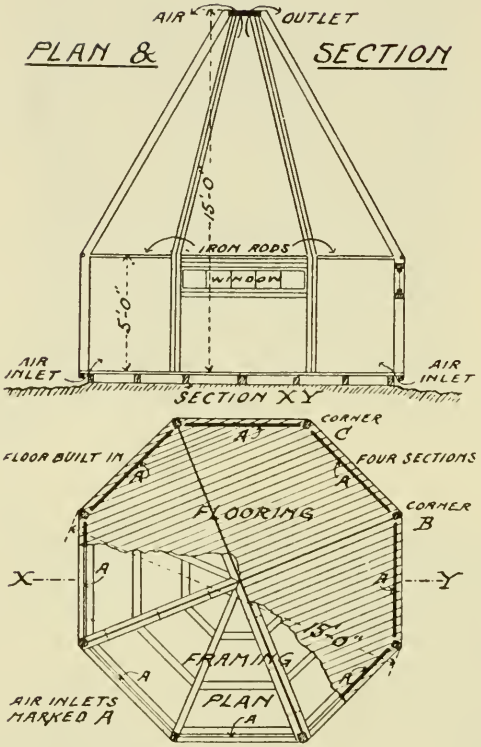


Fig. 59.—Plan and Section of a Ventilated Tent.
(Designed by Dr. Gardiner.)

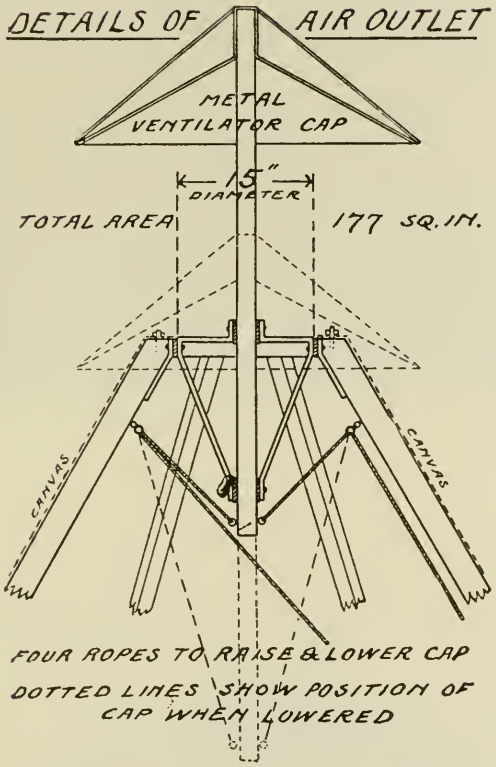


FIG. 60.—DETAILS OF ROOF VENTILATOR ON A TENT.
(Designed by Dr. Gardiner.)

Fig. 61.—Permanent Arrangement for Open-air Treatment in a Country Home.

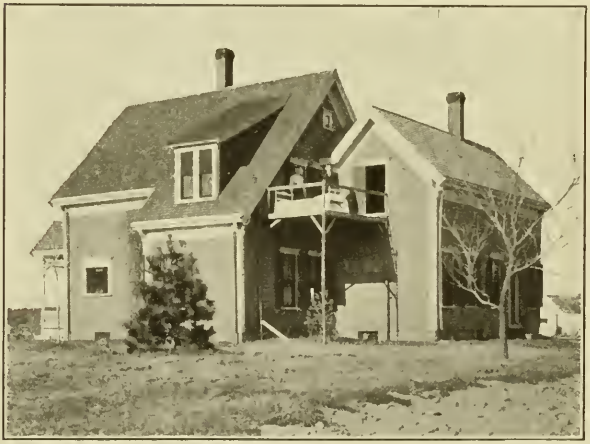


Fig. 62.—Original Sleeping Balcony in Hanover, Mass. Used since June, 1898. (Dr. Millet.)

APPENDIX VIII

DIET LISTS

By Members of the Department of Household Administration, University of Chicago

Abbreviations and Explanations

P. = grams of proteid.
F. = grams of fat.
C. H. = grams of carbohydrates.
Cal. = caloric value of dish.
W. = actual weight, etc., of customary measure in pounds and ounces, or fluid measures (see table of equivalents in Richards, p. 43, and Appendix I).
Dish = name of dish. Follow names given by Mrs. Richards and take quantities from table of recipes.
Cust. Meas. = customary measures. Indicated measures are only suggestive, and ought to be replaced if deemed advisable. Tablespoon measure should always mean "heaping," unless specifically indicated.

All measurements are level.
The cup used as the standard is the measuring cup containing one half pint.
The teaspoon is that of average size, containing 5 grams of water.

1 cup = 16 tablespoons
1 tablespoon = 3 teaspoons
1 dessertspoon = 2 teaspoons
28.3 grams = 1 ounce

Abbreviations:

c. = cup
tbsp. = tablespoon
dsp. = dessertspoon
tsp. = teaspoon

Water	1 tsp.	5.00 grams.
	1 dsp.	10.00 grams.
	1 tbsp.	15.00 grams.
Sugar	1 tsp.	4.6 grams.
	1 dsp.	9.20 grams.
	1 tbsp.	13.80 grams.
Butter	1 tsp.	4.50 grams.
	1 dsp.	9.00 grams.
	1 tbsp.	13.50 grams.
Oil	1 tsp.	4.40 grams.
	1 dsp.	8.80 grams.
	1 tbsp.	13.20 grams.

1 lump loaf sugar	6.79 grams.
1 lump domino sugar	7.85 grams.

Calculated on basis 1 dessertspoon the equivalent of 2 teaspoons, 1 tablespoon the equivalent of 3 teaspoons, using 5 gr. as unit weight of 1 tsp. water and ratio between weights of water and other materials; e. g., 5 gr. (wt. of 1 tsp. water) x 0.92 (average ratio between water and sugar)—standard measure—tsp. sugar (4.6 grams).

Customary Measure.	Food.	Actual Weight.	Nutrients Yielded.			Calories.
			Prot.	Fat.	C. H.	
	Beverages.	Grams.	Grams.	Grams.	Grams	
1 cup	Coffee or Tea... ⅔ c. coffee.	154.0	.....	.....	.....	.....
	2 tbsp. cream.	30.0	0.75	5.5	1.4	60.0
	2 lumps (cube) sugar.	14.0	.....	.....	14.0	57.4
	Total.....	198.0	0.75	5.5	15.4	117.4
1 cup	Coffee or Tea... ⅔ c. coffee.	154.0	.....	.....	.....	.....
	2 tbsp. milk.	30.8	1.0	1.2	1.5	21.4
	2 lumps (cube) sugar.	14.0	.....	.....	14.0	57.4
	Total.....	198.8	1.0	1.2	15.5	78.8
1 cup	Cocoa... ¾ c. milk.	184.5	6.1	7.4	9.2	131.6
	2 tsp. cocoa.	4.8	1.0	1.4	1.8	24.5
	1 tsp. sugar.	4.6	.....	.....	4.6	18.9
	Total.....	193.9	7.1	8.8	15.6	175.0
1 tumbler	Milk (⅞ c.).....	222.6	7.3	9.0	11.1	159.1
	Eggnog. ¾ c. milk.	184.5	6.1	7.4	9.2	131.6
	1 egg.	50.0	6.7	5.3	.....	76.8
	1 tsp. sugar.	4.6	.....	.....	4.6	18.9
	Total.....	239.1	12.8	12.7	13.8	227.3
1 tumbler	Egg malted milk.. 1 egg.	50.0	6.7	5.3	.....	76.8
	1 tbsp. malted milk.	7.0	1.0	5.4	0.4	56.0
	2 tsp. chocolate.	4.8	0.6	2.3	1.5	30.0
	1 tsp. sugar.	4.6	.....	.....	4.6	18.9
	2 tbsp. cream.	30.0	0.8	5.5	1.4	60.0
	Total.....	96.4	9.1	18.5	7.9	241.7

Customary Measure.	Food.	Actual Weight.	Nutrients Yielded.			Calories.
			Prot.	Fat.	C. H.	
	Fruits and Nuts.	Grams.	Grams.	Grams.	Grams.	
1 large.	Orange	251.0	1.5	0.3	21.3	96.3
1 large.	Banana	152.0	1.2	0.6	21.7	99.5
½ c.	Strawberries (hulled)	73.0	0.7	0.4	5.4	28.7
6 large.	Prunes (not cooked)	93.0	1.0	.....	36.0	151.7
1 medium.	Apple	142.0	0.4	0.4	15.3	68.1
10 shelled.	Peanuts	17.0	4.4	6.56	4.1	96.2
10 shelled.	Almonds	10.5	2.2	5.8	1.8	70.3
12 halves.	Pecans	11.5	1.1	8 1	1.8	88.2
	Cereals.					
⅓ c.	CEREAL AND CREAM.					
	⅓ c. rolled oats	81.5	2.28	0.4	9.47	51.9
	4 tbsp. cream	60.0	1.5	11.0	2.8	120.0
	Total	141.5	3.78	11.4	12.27	171.9
	CEREAL AND MILK AND SUGAR.					
	⅓ c. rolled oats	81.5	2.28	0.4	9.47	84.30
	4 tbsp. milk	61.6	2.0	2.5	3.0	43.8
	1 tbsp. sugar	13.8	.....	.....	13.8	56.6
	Total	156.9	4.28	2.9	26.27	184.70
⅓ c. small serving.	CORN MEAL MUSH AND CREAM.					
	⅓ c. mush	82.3	1.15	0.64	10.0	51.68
	4 tbsp. cream	60.0	1.5	11.0	2.8	120.0
	Total	142.3	2.65	11.64	12.8	171.68
	CORN MEAL MUSH, MILK AND SUGAR.					
	⅓ c. mush	82.3	1.15	0.64	10.0	51.68
	4 tbsp. milk	61.5	2.0	2.5	3.0	43.8
	1 tbsp. sugar	13.8	.....	.....	13.8	56.6
	Total	157.6	3.15	3.14	26.8	152.08
	Bread and Cake.					
1 slice.	Homemade bread (thin)	28.0	2.5	0.4	15.0	75.5
1 slice.	Homemade bread (thick)	39.0	3.5	0.6	20.8	105.2
1 slice.	Baker's bread (thin)	17.0	1.6	0.2	9.0	45.3
1 slice.	Baker's bread (thick)	28.0	2.6	0.3	14.8	74.1
1 slice.	Toast	26.0	3.0	0.4	16.0	81.6
1 slice.	Brown bread	69.0	3.7	1.2	32.5	159.6
1 slice.	Whole wheat bread	21.0	2.0	0.2	10.4	52.7
1	Roll, plain, as purchased (medium)	47.0	4.6	2.0	28.2	153.1
1	Roll (sweet, large)	66.0	6.2	0.5	39.2	190.8
1	Doughnut (medium)	44.0	3.0	9.2	23.4	193.8
1 piece.	Sponge cake	19 0	1.2	2.0	12.5	74.8
1 piece.	Frosted cake (2 x 2)	44.0	2.6	4.0	28.5	164.7
1 piece.	Jelly roll	30.0	1.5	2.3	21.0	113.6
1	Square wafer	8.3	0.8	0.8	6.1	35.7
	Butter for 1 slice bread	4.0	0.04	3.4	.....	31.8
1	Butter ball or 1 cube butter.	14.0	0.1	12.0	.....	112.0

Customary Measure.	Food.	Weight	Nutrients Yielded.			Calories.
			Prot.	Fat	C. H	
	Soups.	Grams.	Grams.	Grams	Grams.	
¾ c.	Consommé	177.0	4.4	.....	0.7	20.9
¾ c.	Cream of tomato	178.0	4.5	12.5	11.5	181.9
¾ c.	Cream of corn	163.8	4.1	3.1	12.8	98.1
¾ c.	Vegetable soup	179.0	5.2	.....	0.9	25.0
¾ c.	Cream of pea soup	170.0	4.4	4.6	9.7	100.6
¾ c.	Potato soup	183.5	6.6	10.8	18.6	203.8
1 c.	Clam chowder	245.0	4.5	12.1	12.6	182.6
1 c.	Fish chowder	245.0	12.9	6.8	16.8	185.0
¾ c.	Cream of asparagus	170.0	4.3	5.4	9.4	106.4
¾ c.	Cream of celery	170.00	3.6	4.8	8.5	94.3
1 c.	White sauce	.....	9.9	33.0	23.7	444.7
2 tbsp.	White sauce	.....	1.2	4.1	3.0	55.4
	Fish and Meat.					
1 piece.	Halibut	75.0	13.0	3.7	.....	87.7
1 piece.	Whitefish	75.0	9.0	2.6	.....	61.1
	Creamed halibut	121.5	14.2	7.8	3.0	143.1
1	Lamb chop	82.0	17.8	24.5	.....	300.8
½ c.	Lamb stew	110.0	20.5	32.8	4.2	406.3
½ c.	Beef stew	110.0	5.1	4.7	6.0	89.2
½ c.	Veal stew	110.0	22.3	15.8	4.2	255.6
1 patty.	Hamburg steak (without bone)	85.0	18.8	31.2	.....	367.24
1 piece.	Lean steak	85.0	23.5	6.5	....	156.8
1 piece.	Fat steak	85.0	20.0	17.3	.....	242.9
1	Pork chop	85.0	17.0	30.9	....	357.1
1 slice.	Pork tenderloin	50.0	14.2	9.8	.....	149.4
1 slice.	Mutton roast	42.7	10.7	9.7	.....	134.1
1 slice.	Veal roast	59.2	18.0	8.0	.....	148.3
1 slice.	Beef (medium slice)	75.0	19.4	11.1	.....	182.8
1 slice.	Beef (large slice)	105.0	27.2	15.5	.....	255.7
1 slice.	Liver	25.0	7.7	1.7	.....	47.4
2 slices.	Broiled bacon	14.0	3.5	12.0	.....	126.0
½ c.	Corn beef hash	94.0	5.3	10.0	8 8	157.3
½ c.	Creamed dried beef	106.0	17.7	18.4	5.1	264.6
2 slices.	Chicken breast	41.0	13.2	1.5	....	68.1
	Chicken upper joint	57.0	10.9	1.2	.....	55.9
	Chicken drumstick	60.0	11.5	1.3	.....	59.2
	Egg Preparations					
1	Whole egg	50.0	6.7	5.3	.....	76.8
1	Egg white	30.0	3.7	0.06	.....	15.7
1	Egg yoke	20.0	3.1	6.7	.....	75.12
1	Egg omelet: 1 egg	50.0	6.7	5.3	.....	76.8
	1 tbsp. milk	15.4	0.5	0.6	0.8	10.9
	1 tbsp. butter	4.5	0.05	3.8	.....	35.5
	Total	.....	6.80	9.16	0.8	116.2
½ c.	Creamed egg: 1 egg	50.0	6 7	5.3	.....	76.8
	⅓ milk	81.7	2.7	3.3	4.1	58.6
	⅔ tbsp. butter	9.0	0.1	7.7	....	72.0
	⅔ tbsp. flour	5 0	0.5	0.1	3.8	18.6
	Total	.....	10.0	16.4	7.9	342.0

Customary Measure.	Food.	Weight.	Nutrients Yielded			Calories
			Prot	Fat.	C H	
	Egg Preparations (Continued)	Grams	Grams	Grams	Grams	
½ c.	Custard { ½ c. milk	122.5	4.0	4.9	6.1	87.0
	½ egg	25.0	3.4	2.7	.....	38.4
	1 tbsp. sugar	13.8	.....	.....	13.8	56.6
	Total	.....	7.4	7.5	19.9	182.0
1 c.	Milk	245.0	8.1	9.8	12.3	174.8
	Vegetables.					
⅔ c.	Baked beans	153.0	10.6	3.8	30.0	201.8
½ c.	Potato (mashed) (unbaked) 140	99.0	2.6	3.0	17.6	110.7
1	Potato (baked)	105.0	3.1	0.1	25.8	119.4
1	Potato (boiled)	91.0	2.3	0.1	19.0	88.3
¾ c.	Potato chips	28.0	2.0	11.1	13.1	165.1
⅔ c.	Lima beans	74.0	3.0	0.2	10.8	58.4
⅓ c.	Green peas	62.0	2.2	0.1	6.1	35.0
⅓ c.	Corn	100.5	2.8	1.2	19.1	101.0
½ c.	Tomatoes	128.0	1.5	0.2	5.1	29.9
⅓ c.	String beans	110.9	1.2	0.1	4.2	23.1
½ c.	Rice	99.0	2.8	0.1	24.2	111.6
	R. D. C.					
½ c.	Rice and cheese	85.0	12.5	13.9	38.5	338.4
½ c.	Macaroni	79.0	2.4	1.2	25.5	72.3
	R. D. C.					
½ c.	Macaroni and cheese	79.0	8.5	12.9	22.6	247.5
1 medium.	Sweet potato (176 g. before baking)	129.0	3.9	2.7	54.3	263.7
	Desserts.					
1 piece.	Shortcake	184.0	8.2	24.6	43.8	1472.0
	Cake	69.0	6.4	16.4	36.3	327.6
½ c.	Berries	73.0	0.7	0.4	5.4	28.7
6 tbsp.	Whipped cream	42.0	1.1	7.8	2.1	85.7
½ c.	Cornstarch pudding	95.0	6.0	7.3	28.2	209.1
¾ c.	Milk	183.8	6 0	7.3	9.3	131.6
¾ tbsp.	Cornstarch	5.7	.....	...	5.1	20.9
1 tbsp.	Sugar	13.8	.....	.....	13.8	56.6
½ c.	Rice pudding	142.0	7.8	6.5	44.7	276.2
	Rice	32.6	2.6	0.1	25 8	117.4
	Milk	160.7	5.3	6.4	8.0	114.1
	Sugar	10.9	.....	.....	10.9	44.7
1 slice.	(⅛ qt.) ice cream (home-made)	70.0	2 1	10.5	11.4	153.0
1	Baked apple	120.0	0.7	0.9	.....	.....
½ c.	Bavarian cream	116.0	3 84	6 3	17.7	146.7
½ c.	Orange sponge	109.0	3.3	4.7	26.6	166.3
½ c.	Lemon jelly	95.0	1.6	0.001	28.1	121.8
	Miscellaneous.					
1 tbsp.	Mayonnaise	19.0	0.3	15.6	0.1	146.7
1 c.	Mayonnaise	305.0	4.2	248.9	2.3	2314.1
1 tbsp.	Maple sirup	21.0	.....	.....	15.0	61.5
1 c.	Maple sirup	311.0	.....	.....	222.0	910.2
1 tbsp.	Molasses	19.0	0.5	.....	13.2	56.2
1 c.	Molasses	331.0	10.0	.....	229.3	981.2
1 tbsp.	Cream, thin	14.0	0.4	2.6	0.6	28.3
1 c.	Cream, thin	224.0	5.6	41.4	10.1	449 4
1 inch cube.	Cheese	17.0	4.9	6.1	0.05	77.0

BIBLIOGRAPHY

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